Chemical Engineering

A McGRAW-HILL PUBLICATION

DECEMBER 15, 1958
Published every-other-Monday
Seventy-five cents

WHERE
to buy your
construction materials

HOW
to pick metals
for high temperatures

18th biennial
40-PAGE
SPECIAL REPORT ON

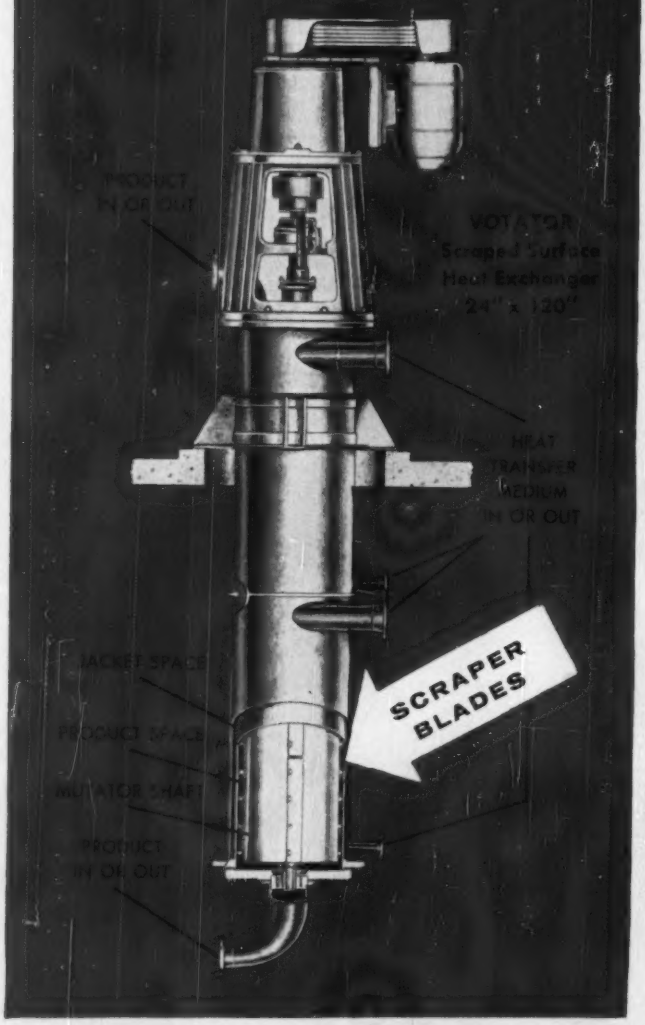
MATERIALS OF CONSTRUCTION

Votator®

SCRAPED SURFACE

HEAT EXCHANGERS

...key to high
heat-transfer efficiency



WHETHER YOU ARE developing a new process or improving your existing process, you'll get profitable help from VOTATOR* SCRAPED SURFACE Heat Exchangers. These units process heat-sensitive or viscous liquids continuously under closely controlled temperature and pressure. The unexcelled heat transfer rates obtainable are due to design principles wherein violent agitation, combined with continuous scraping of the heat transfer surface, produces thin films and high turbulence. Internal design provides a high ratio of heat transfer surface to volume of material and features high jacket velocities and turbulent flow of the heat transfer medium. Since processing is continuous, high throughput rates are obtained in small sized equipment.

VOTATOR Heat Exchangers are available in sizes of 0.7 square feet to 60 square feet of heat transfer surface . . . in capacities of 50 to 50,000 pounds/hour . . . for indoor or outdoor installation. Write for complete information.

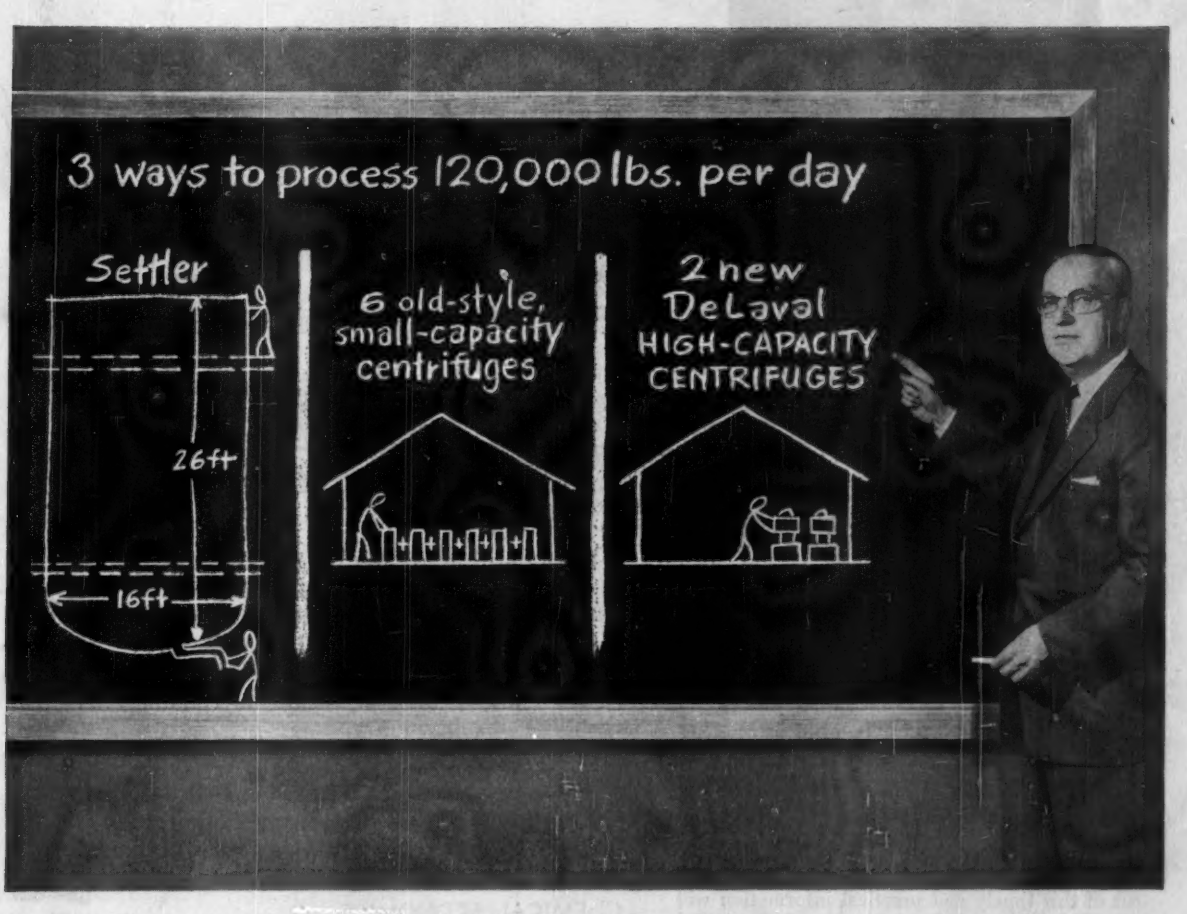
*VOTATOR and THERMEX — Reg. U. S. Pat. Off.

OVERALL HEAT TRANSFER RANGES

Material	Overall U Range (BTU/HR/FT2/°F)
Thin Liquid	400 — 700
Viscous Liquid	150 — 400
Crystallization	150 — 650
Sulfonation	150 — 400
Polymerization	200 — 500

GIRDLER PROCESS EQUIPMENT DIVISION

CHEMETRON



Blackboard sketches show relative space required by settler versus small centrifuges versus new high-capacity centrifuges

"High-capacity centrifuges offer important savings in manpower and floor space"

Fred Wheelwright, De Laval Separator Co.

WITH floor space costing what it does today, we wonder if processors realize just how expensive settling tanks really are. The blackboard sketch above gives you a rough idea of how much floor space (and cubic space too) you can save with centrifuges . . . especially De Laval's newest high-capacity machines.

As you can see, two high-capacity centrifuges equals the capacity of six old style machines equals one enormous settling tank. In addition, the centrifuges turn batching into continuous processing, create higher yields of more uniform quality . . . at far lower labor costs.

To give a typical example:
A southern vegetable oil refiner had a large four-story plant containing settling tanks. When they changed over to the centrifuge method, they knocked out the floors of one bay . . . built a small two-story brick refinery inside the old shell. Later they knocked off the old walls and roof, let the new plant stand outdoors. Then they turned the settling tanks into storage facilities. Their new refinery takes less than a third the space of their old plant and needs only half the manpower for the same production. And, yields and quality are far higher.

De Laval can give you many similar cases where high-capacity centrifuges save space and manpower, improve yield and quality. If you'd care to send us the design criteria for your product or process data on your separation problems, our Engineering Department will give it a careful analysis and submit their objective recommendations. All in strict confidence, naturally. And our complete pilot plant facilities are at your disposal.

If you'd like a four-page brochure of specifications on the De Laval line of centrifuges for the process industries, just write on your letterhead.

DE LAVAL
SEPARATOR COMPANY

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York
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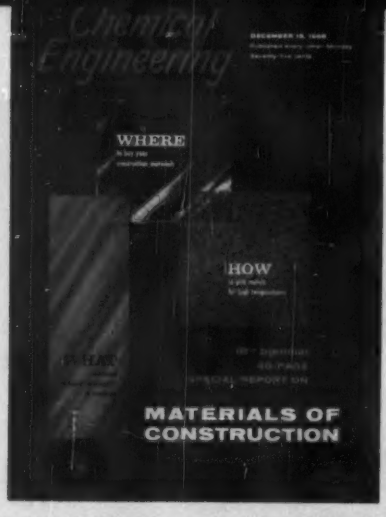
201 E. Millbrae Avenue, Millbrae, Calif.



TWENTY-FIFTH OF TWENTY-SIX ISSUES

25/26

Chemical

DECEMBER 15, 1958

What metals for high temperatures?

When your processing temperatures get up into the 400-2,000 F. range, what metals can you use for your materials of construction? *Chemical Engineering's* latest report is your most up-to-date guide. Here you have a run-down on the principles behind selection; descriptions of the metals and alloys available today; and a review of how they behave when ultra-hot. All of this timely and practical information will help you pick your metals; steer you away from costly application errors. (p. 137)

Who are the materials manufacturers?

Regular feature of your biennial reports is the comprehensive tabulation of manufacturers of all the regularly used materials of construction. Here's where you find who makes what, forms available, principal uses, compositions and other data. It's best and fastest from A to Z. (p. 148)

How to get even more information?

Here's a novel new service: Listed for your convenience are hundreds of current technical literature items that materials of construction manufacturers have available and waiting to help you. It's a checklist giving size, content and other facts about literature you can get today to answer your specific questions about materials. (p. 171)

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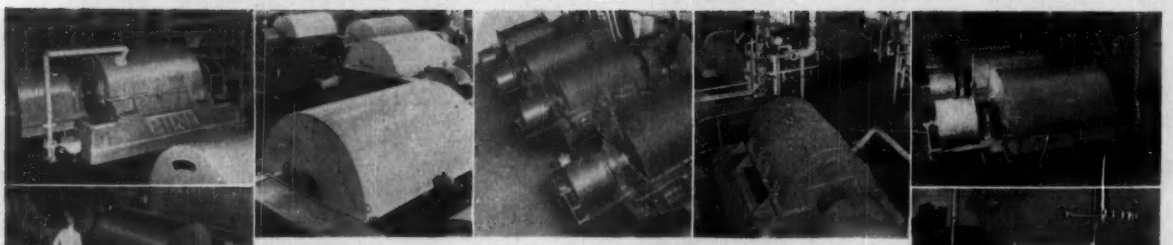

Your Solid-Liquid Separators belong in this picture

These Bird Continuous Solid-Bowl Centrifugal installations, and hundreds like them, cover everything from aluminum hydrate to zinc sulphide, from coal to cryolite, from ultramarine pigment to uranium.

All have one thing in common. They make highly effective use of positive, powerful centrifugal force to do the separating job.

All we ask is the chance to determine (by pilot-scale test of the actual slurry at the Bird Research and Development Center, if need be) whether *your* solid-liquid separations can be accomplished *better, faster and at lower cost* by this modern method.

Isn't this something you'd like to know? If so, just get in touch with us.

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LEADING AUTHORITY ON SOLID-LIQUID SEPARATIONS

Builders of

- Bird Continuous Centrifugal Separators
- Bird-Prayon Continuous, Rotary, Horizontal Vacuum Filters
- Bird-Young Single Cell Rotary Vacuum Filters
- Bird Horizontal Tank, Vertical Leaf Pressure Filters
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South Walpole, Mass.

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Chemical Engineering

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DEC. 15, 1958

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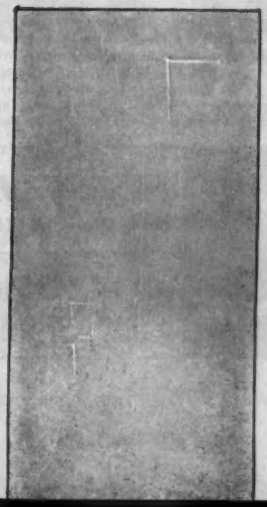

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Trimellitic anhydride—first of a series of aromatic acids resulting from Scientific Design-Standard-Amoco oxidation process—can hydrolize, esterify, condense and more.

Materials of construction—18th biennial report..... 137

Here's useful information on what metals to use in high-temperature processing. Also: New listing of major manufacturers and inventory of construction literature.

Chemical Engineering (with Chemical & Metallurgical Engineering) is published biweekly by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder Publication Office: 99-129 North Broadway, Albany 1, N. Y. **Executive, Editorial, Circulation and Advertising Offices,** 330 West 42nd St., New York 36, N. Y. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice President; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary; Officers of the Publications Division: Nelson L. Bond, President; Harry L. Waddell, Senior Vice President; Ralph B. Smith, Vice President and Editorial Director, Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

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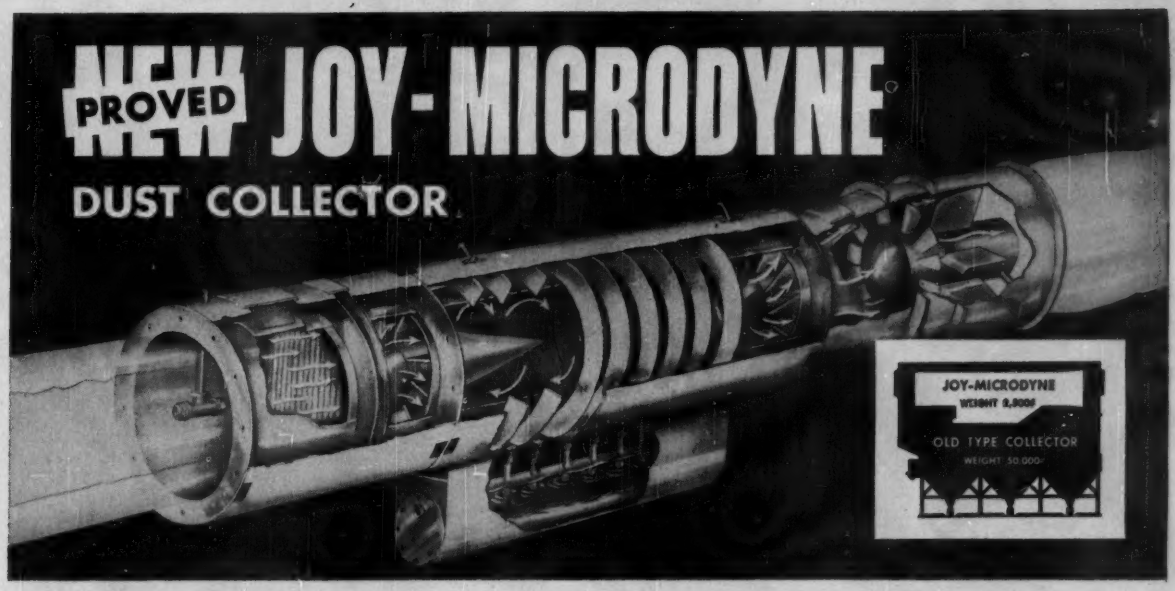
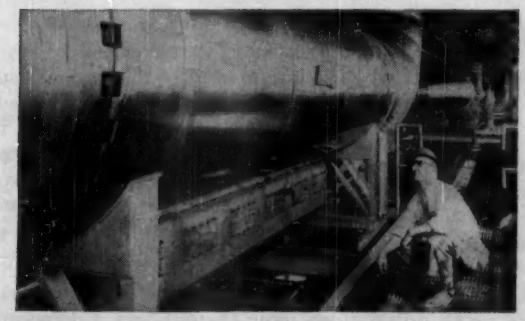


Profile of a Problem Solver

Here is an in-duct "educated pipe" that laughs at space, weight and water limitations as it collects over 99% of dust 5 microns and larger; 92% of 2-micron dust, and substantial amounts of smaller dust.

Particles enter through water-saturated air, slam against a water-film-covered impingement element, encase themselves in water droplets as they pass through, then whirl and collect on the sides of the middle section, to finally drain into a sump. Cleaned air is straightened and thrust on its way by an integral Joy Axivane Fan.



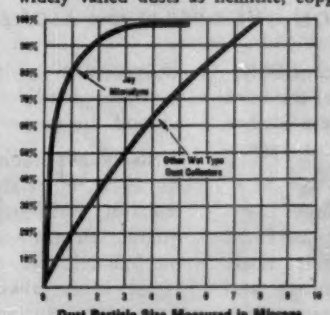
This 48,000 cfm installation shows compact assembly and space economy of in-duct placement.

SAVES SPACE—Installs as an integral section of duct-work; requires only 1/10 to 1/20 the space of conventional units. 2500 cfm unit is 10 feet long; 1.5 feet in diameter.

SAVES WEIGHT—Even the largest unit—64,000 cfm, 5 feet in diameter, 32 feet long—weighs only 6,500 pounds . . . or 1/5 the weight of conventional collectors. 2,500 cfm unit weighs only 325 pounds.

SAVES WATER—The largest Joy collector requires only 48 GPM flow—much less than comparable wet collectors. Add a Delpark Filter (Sold by Joy) and water can be recirculated to recover valuable dusts. The filter also reduces water borne solids to give a dependable, clear water supply from a dirty water source.

SUCCESSFUL INSTALLATIONS—Joy collectors from 500 cfm through 64,000 cfm are *now in use* collecting such widely varied dusts as hemitite, copper and uranium ores, coal, quartz, limestone, phosphate, stainless steel and titanium carbide grindings. For answer to your dust collecting problems, write, wire or call: ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** *In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*



Performance graph of actual installation shows efficiency of the Joy-Microdyne Dust Collector. (A micron is 1/25,000 inch)

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Trims handling costs almost 90%

SAVES 21 MANHOURS OF HARD LABOR DAILY ON ONE OPERATION ALONE

H. Swoboda & Son, Inc. of Philadelphia have taken a lot of the hard physical labor out of their leather tanning operations and cut operating costs at the same time.

It all started when Chief Engineer, E. C. Sharpless, looked for a better way to load their waste materials — hide trimmings and flesh — into trucks. He recommended a tractor-shovel to do the job, so competitive makes were called in to demonstrate, with the result that a Hough model H-25 "PAYLOADER" with an open-tine type bucket was purchased. It was found that this machine could easily load 53,000 lbs. of material in 3 hours — as much as three men with pitchforks could do in an 8-hour day, or 24 manhours. Needless to say, this was just a beginning for the versatile "PAYLOADER", as it is being applied to other materials handling jobs around the tannery.

Swoboda's decision to purchase the H-25 rather than a competitive machine was based not alone on greater production, but also on mechanical and operating advantages. More power, greater lifting capacity, exclusive non-spin differential that gets traction even on their slippery floors, and speed and ease of maneuvering in congested plant areas were some of its features that they found important in their operations.

Operator's safety and comfort and ease of operation were also noted due to the power-steer, power-shift transmission, underslung safe boom arms and low, stable load-carry position.

Bob Merrell of the Swoboda staff — an experienced front-end loader operator — gave his opinion of the model H-25 in a few well-chosen words, "Man this is the greatest — handles more, loads more, faster than anything else . . . easy to get in and out of tight places."

If you have bulk, loose materials to move, better have a demonstration of the model H-25. You'll find it's the "greatest" too . . . that it can do many tough materials handling jobs at low cost. Ask your "PAYLOADER" Distributor about Hough Purchase and Lease Plans also. The Frank G. Hough Co., 754 Sunnyside Ave., Libertyville, Ill.

10-A-2

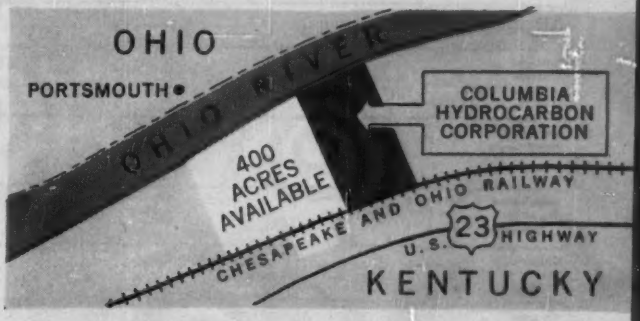
Modern Materials Handling Equipment
THE FRANK G. HOUGH CO.
LIBERTYVILLE, ILLINOIS
DIVISION—INTERNATIONAL HARVESTER COMPANY

Opportunity for ethylene users

Columbia Hydrocarbon Corporation, subsidiary of The Columbia Gas System, Inc., has available, for its recently completed fractionation plant at Siloam, Kentucky, raw materials for the production of up to 350 million pounds of ethylene per year. The company is prepared to discuss the sale of ethylene with interested chemical companies.

The Columbia Hydrocarbon property fronts on the Ohio River opposite Portsmouth, Ohio. There is available in the immediate area cleared and level land suitable for chemical facilities necessary to use ethylene as a raw material. A fine transportation network – the C&O Railway, barges and highways – serves this section, water is abundant (both from the Ohio River and from wells).

Power is ample and dependable. Labor is mainly native born and the local attitude is favorable to development. Another advantage of the area is its central location in relation to the nation's consumer markets.



Detailed information on plant sites for ethylene users will be furnished in complete confidence. Just write or call: Chesapeake and Ohio Railway, Industrial Development Department, Huntington, West Virginia.

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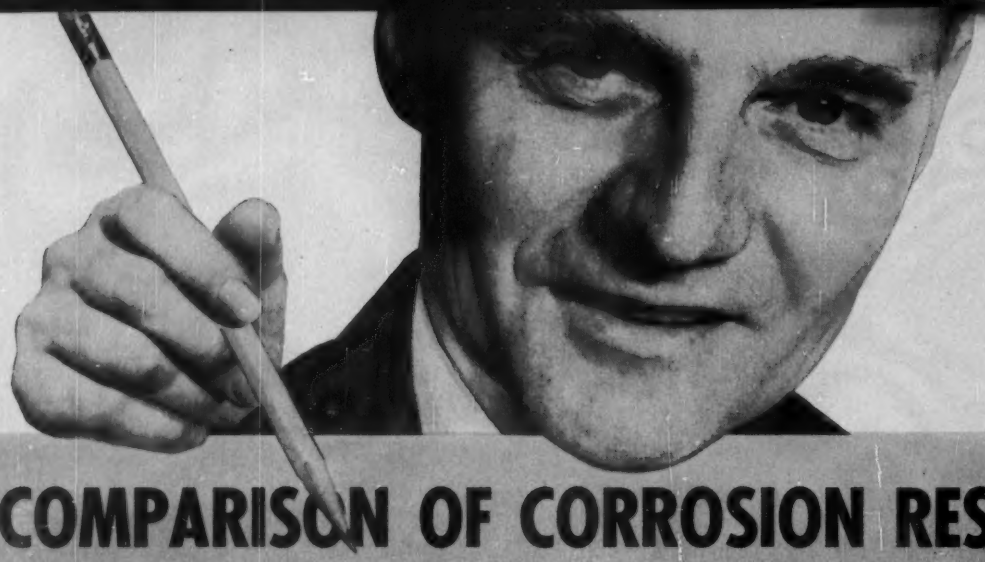

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ZIRCONIUM • TITANIUM • TANTALUM • HASTELLOY "C" • STAINLESS 316

REAGENT	ZIRCONIUM	TITANIUM	TANTALUM	HASTELLOY "C"	TYPE 316 STAINLESS STEEL
Acetic Acid	5-99.5% 35°-100°C. Excellent	5-99.5% 35°-100°C. Excellent	All conc. 20°-392°C. <5 mils/yr.	All conc. 20°C. boiling Excellent	5%-100% Room temp. Excellent 25%-100% Boiling Fair
Alcohol Methyl	99% 65°C. (boiling) Excellent	99% 35°C. 4 mils/yr.	All conc. Room-boiling <5 mils/yr.	All conc. Room-boiling Excellent	99% Room temp. 20 mils/yr. 70°C. 4-42 mils/yr.
Aluminum Chloride	10-30% 20°C. boiling Excellent	10% 35°-100°C. Excellent 25%-100°C. 258 mils/yr.	All conc. Room-100°C. <5 mils/yr.	20% Room temp. 20 mils/yr.	All conc. 20°C. 42-752 mils/yr.
Aluminum-Potassium Sulfate (Alum)	10-90% Room-boiling Excellent			10% 20°-80°C. 2-20 mils/yr.	10% Room-boiling 4 mils/yr. Satd.-boiling 4-40 mils/yr.
Aniline Hydrochloride	5-20% 35°-100°C. Excellent	5-20% 35°-100°C. Excellent			20°C. 40-120 mils/yr.
Aqua Regia	Conc. 19°-26°C. Not recommended	Conc. 19°-60°C. Excellent	Conc. 19°-60°C. Excellent		
Barium Chloride	5-20% Room-100°C. Excellent	5-20% Room-100°C. Excellent		All conc. Room-50°C. 2-20 mils/yr. 15-25% 100°C. Excellent	5-25% Room temp. 20 mils/yr.
Barium Hydroxide	15-50% 100°C. Excellent			5-50% Room-100°C. 2-20 mils/yr.	
Bromine Water	2% 100°C. Excellent			100% Room-100°C. Excellent	20°C. 40-120 mils/yr.
Calcium Chloride	10-65% 20°-100°C. Excellent	5-25% 35°-100°C. Excellent		All conc. 20°C.-100°C. 2-20 mils/yr.	Dil.-Conc. 70°F. 4 mils/yr. (Subject to pitting)
Calcium Hypochlorite	6% 35°-100°C. Excellent	6% 35°-100°C. Excellent		10-20% 20°-50°C. 20 mils/yr.	2-6% 35°-100°C. Fair to excellent (Subject to pitting)
Chlorinated Water (Saturated)	Room temp. Excellent	Room temp. Excellent		Room temp. Excellent 65°C. 2-20 mils/yr.	Room temp. 4-42 mils/yr.
Chlorine Gas (Wet)	Room temp. Not recommended	Room temp. Excellent	Room temp. <5 mils/yr.	20°-80°C. 2-20 mils/yr.	20°-100°C. 400 mils/yr.
Chromic Acid	10-30% 20°-100°C. Excellent	20% 20°C. 4 mils/yr.	All conc. and temp. <5 mils/yr. Slight attack at high temp. and conc.	All conc. 20°-80°C. 2-20 mils/yr.	10-50% 20°-100°C. 4-120 mils/yr.

REAGENT	ZIRCONIUM	TITANIUM	TANTALUM	HASTELLOY "C"	TYPE 316 STAINLESS STEEL
Citric Acid	10-30% 35°C. boiling Aerated & non-aerated Excellent	10-50% 35°C.-boiling Excellent Boiling non-aerated. Fair	All conc. 20°-100°C. <5 mils/yr.	All conc. 20°-100°C. Excellent	5-15% 20°-70°C. 4 mils/yr. 25%-conc. boiling 4-120 mils/yr.
Cupric Chloride	1% 35°C.-60°C. Excellent Over 2.5% 35°-100°C. Fair to not recommended	1-20% 35°-100°C. Excellent		All conc. 35°C.-100°C. 2-20 mils/yr.	1-5% 20°C. 4-120 mils/yr. (Subject to pitting)
Dichloroacetic Acid	100% 35°-100°C. Fairly good	100% 100°C. Excellent			
Ethylene Dichloride	50% Boiling Excellent	50% Boiling Excellent			
Ferric Chloride	1-5% 35°-60°C. Excellent Over 5% 100°C. Over 15% 35°C. Fair to not recommended	1-20% 35°-100°C. Excellent	All conc. 20°-100°C. <5 mils/yr.	5-45% 20°C. 20 mils/yr. 20%-70°C. 20-50 mils/yr.	1-5% 20°C. 4-120 mils/yr.
Formic Acid	10-90% 35°-100°C Aerated & non-aerated & static Excellent	10-90% 35°-100°C. Excellent Boiling & non-aerated 96 mils/yr.	All conc. 20°-100°C. <5 mils/yr.	All conc. 20°C. Excellent 100°C. 2-20 mils/yr.	5-30% 20°-100°C. 4-50 mils/yr.
Hydrochloric Acid	1-37% 35°C. Excellent Dilute-boiling Excellent Conc. boiling Fair Boiling under pressure Excellent to poor, depending on carbon	½-5% 60°C. Excellent Over 6%-60°C. Over 1.5%-100°C. 100 mils/yr.	All conc. 20°-100°C. <5 mils/yr.	All conc. 20°C. 2-50 mils/yr. Over 70°C. 50 mils/yr.	All conc. 20°C. 420 mils/yr.
Lactic Acid	10-85% 35°-100°C. Excellent	10-85% 35°-100°C Excellent		1-55% 20°-50°C. Excellent	5% 20°-70°C. 4 mils/yr. 10% 70°-180°C. 4-42 mils/yr.
Magnesium Carbonate	5% 100°C. Excellent			5-100% 20°-100°C. 2-20 mils/yr.	
Manganese Chloride	5-20% 35°-100°C. Excellent	5-20% 35°-100°C. Excellent			
Mercuric Chloride	1%-Satd. 35°-100°C Excellent	1%-Satd. 35°-100°C Excellent		5% 20°-80°C. 2-20 mils/yr.	Dilute (pitting) 40-120 mils/yr.
Monochloroacetic Acid	100% 100°C. Excellent	100% 100°C. Excellent		All conc. 20°-100°C. 20 mils/yr.	20°C. 25-100% 50 mils/yr.
Nitric Acid	10%-conc. 35°-100°C. Excellent	5%-conc. 35°-100°C. Excellent to good	All conc. 20°-100°C. <5 mils/yr.	5-70% 20°C. 20 mils/yr. 5-70% 70-100°C. 50 mils/yr.	5%-conc. 20°C. 4 mils/yr. 65%-100°C. 42-120 mils/yr.

DAMASCUS TUBE COMPANY

STAINLESS STEEL TUBING AND PIPE

GREENVILLE, PENNSYLVANIA

CORROSION-RESISTANT TUBING

IS IT PRACTICAL AND ECONOMICAL?

EXCELLENT—0 to 3 mils per year
GOOD—over 3 to 6 mils per year
FAIRLY GOOD—over 6 to 12 mils per year
FAIR—over 12 to 25 mils per year
SLIGHT—over 25 to 50 mils per year
NOT RECOMMENDED—over 50 mils per year

REAGENT	ZIRCONIUM	TITANIUM	TANTALUM	HASTELLOY "C"	TYPE 316 STAINLESS STEEL
Nitric Acid (Red fuming)	20°-70°C. Weight Gain Excellent	70°C. Excellent			
Nitric Acid (White fuming)	20°-70°C. Weight Gain	20°C. 4 mils/yr.			
Oxalic Acid	½-25% 35°-100°C. Excellent	5-25% 35°-100°C. 5-200 mils/yr.	Satd. 96°C. Excellent	All conc. 20°-100°C. 2-20 mils/yr.	5% 20°-100°C. 4 mils/yr. 10% boiling 4-120 mils/yr.
Phosphoric Acid	5-85% 35°-60°C. Excellent 60-85% 100°C. Good to not recommended	1-30% 35°C. 1-25% 60°C. 1-3% 100°C. Excellent 15-85% 60°-100°C. 50 mils/yr.	5-85% 20°-250°C. <5 mils/yr.	5-85% 20°C. Excellent 5-85% 70°-100°C. 20 mils/yr.	1-10% 20°C. 120 mils/yr. 25-75% 100°C. 20 mils/yr.
Potassium Hydroxide	10-40% 20°-100°C. Excellent		5% 100°C. Excellent 40%-100°C. Destroyed	5-50% 20°C.-100°C. 2-20 mils/yr.	5-50% 20°C.-100°C. 20 mils/yr.
Silver Nitrate	0.8% 20°C. Excellent		All conc. 20°-100°C. <5 mils/yr.		
Sodium Hydroxide	10-50% 20°-100°C. Excellent	10% 100°C. Excellent 40% 80°C. Good	5-10% 100°C. Excellent 40% 100°C. Destroyed	5-70% 20°-100°C. 2-20 mils/yr.	25-75% 60°-100°C. 20 mils/yr.
Sodium Hypochlorite	0.5% 35°-100°C. Excellent	0.5% 35°-100°C. Excellent		0.5% 35°-100°C. Excellent	0.5% 35°-100°C. Good
Stannic Chloride	5-24% 35°-100°C. Excellent	5-24% 35°-100°C. Excellent	All conc. 20°-100°C. <5 mils/yr.		25-50% 20°C. 50 mils/yr.
Stannous Chloride	15-75% 100°C. Excellent		All conc. 20°-100°C. <5 mils/yr.		25% 20°C. 50 mils/yr.
Sulfurous Acid	6% 100°C. Excellent	6% 100°C. Excellent		All conc. 20°-100°C. 2-20 mils/yr.	Satd. 20°C. 4-42 mils/yr.
Sulfuric Acid	10-70% 35°-100°C. Excellent 80-96% 35°-100°C. Not recommended	1-3% 60°C. Excellent 2-3% 100°C. 700 mils/yr.	All conc. 20°-145°C. Excellent	All conc. 20°C. 20 mils/yr. Over 50% 100°C. 50 mils/yr.	25-75% 20°C. 50 mils/yr.
Tetrachloroethylene	50% Boiling Excellent	50% Boiling Excellent			
Trichloracetic Acid	100% 100°C. Not recommended	100% 100°C. Not recommended		All conc. 20°-100°C. 2-20 mils/yr.	25-100% 20°C. 50 mils/yr.
Trichloroethylene	50% Boiling Excellent	50% Boiling Excellent		100% 70°-100°C. Excellent	
Zinc Chloride	5-20% 35°-100°C. Excellent	5-20% 35°-100°C. Excellent	All conc. 20°-100°C. <5 mils/yr.		5% 20°-100°C. 42 mils/yr. (Subject to pitting)

This Data Was Accumulated By The National Lead Co. And Other Manufacturers Of Titanium And Zirconium Products

MANUFACTURER OF WELDED PIPE AND TUBING FROM STAINLESS STEEL, ZIRCONIUM AND ZIRCONIUM ALLOYS, TITANIUM, TANTALUM, HASTELLOYS, AND PRECIPITATION HARDENING STEELS.

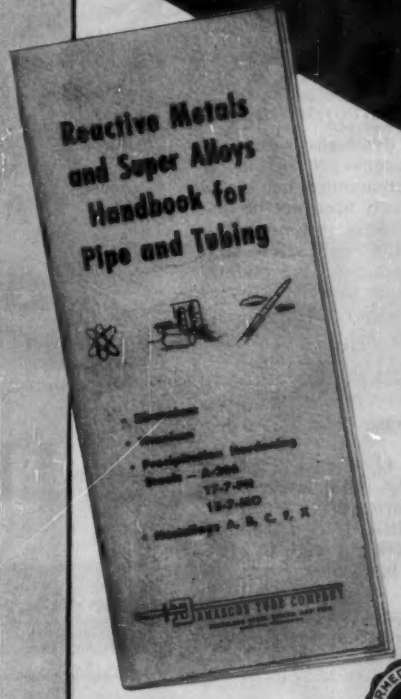
Where handling of corrosive reagents requires frequent replacement of pipe or tubing, we suggest you investigate *special metals* pipe and tubing. Damascus can furnish rare and reactive metals tubing such as titanium, zirconium, and tantalum, which have remarkable resistance to many hard-to-handle reagents. Initially more expensive than stainless steel—service-wise they offer 20 to 30 years of economical, trouble-free operation.

Extremely high operating temperatures and pressures, on the other hand, may dictate use of high strength, high temperature materials such as precipitation hardening steels or HASTELLOY alloys.

For metallurgical assistance in selecting the best materials for your job — write or call today.

NEW! HANDBOOK ON SUPER CORROSION-RESISTANT AND NUCLEAR METALS

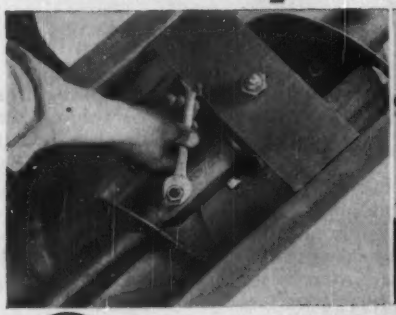
Write for latest information. Applications, corrosion data, chemical analysis and physical characteristics—sizes and grades. For quick reference, a wall chart listing comparative corrosion resistance data on Zirconium, Titanium, Tantalum, HASTELLOY C alloy, and Stainless 316, to 43 common commercial reagents.



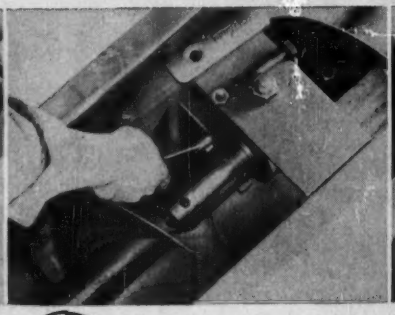
FSTI FORMED STEEL TUBE INSTITUTE

AMERICAN STEEL WAREHOUSE ASS'N

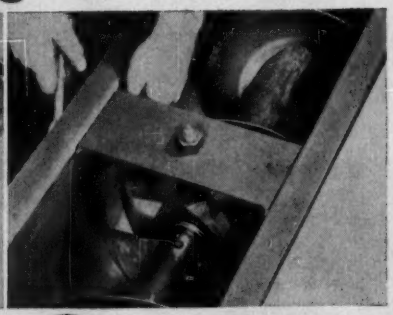
First time you've ever seen a conveyor screw changed so fast!



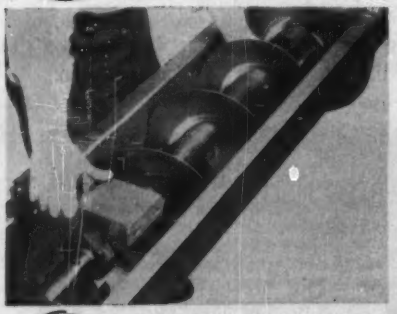
First, take out coupling bolts and filler piece from right-hand end of section to be removed.



Second step: take out coupling bolts and filler piece from the preceding section.



Rotate screw being removed 180 degrees so slot on preceding section is up. Then unbolt hanger.



Now simply lift the conveyor section from the trough and assemble the new one in its place.

RUNNING AGAIN. After less than 30 minutes, the conveyor is back at work.

LINK-BELT Quik-Link conveyor screw eliminates need to pull down entire conveyor line

Down-time is held to the barest minimum with the Quik-Link conveyor screw. It speeds and simplifies the maintenance man's job . . . other components need not be dismantled. And Quik-Link is just one of a whole group of new Link-Belt screw conveyor components that are cutting maintenance and power demands to a new low.

- *BALL BEARING HANGER*—has self-aligning bearing and seal, adjusts to deflection.
- *BALL AND ROLLER BEARING COUNTERSHAFT END*—connects two conveyors at right angles, permits use of a right-angle drive.
- *TROUGH END SEAL*—keeps grease in, dirt out. Used with lip, felt or waste packing seal to prevent bearing-product contact.
- *DOUBLE BALL BEARING FLANGE BLOCK*—resists overhung loads at drive end and takes thrust loads of screw.

For complete facts, call your nearest Link-Belt office or authorized stock carrying distributor. Or write for Folder 2489.

LINK-BELT

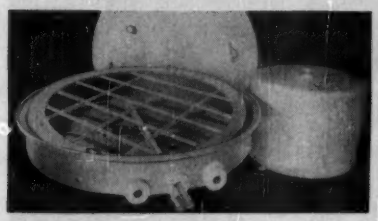
SCREW CONVEYORS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World. 14,883

Big Features of Bonate® Equipment Fabricated by Beetle are

CORROSION RESISTANCE
HIGH STRENGTH
LIGHT WEIGHT

Process Tanks and Pilot Plant Equipment



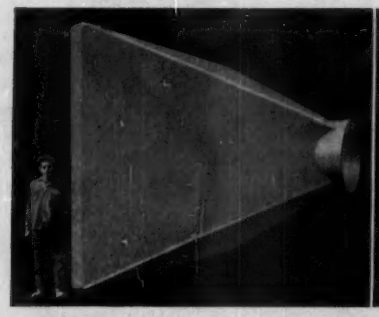
Pickle bath and reservoir tank for hydrochloric and formic acids at 170°F. Installed 1953.

Mild alkaline solution mixing tank. Installed 1954.

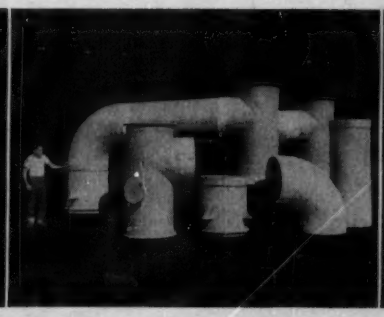
Sulphuric acid head tank. 15% at 120°F. Installed 1954.

Pressure vessel for purifying 35% hydrochloric acid. Working pressure 15 psi. Installed 1955.

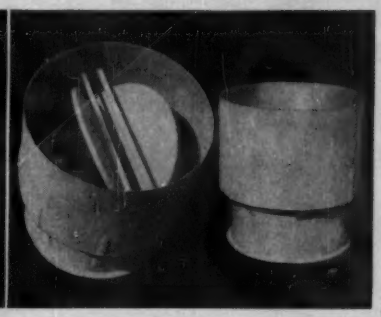
Vents, Ducts, Hoods, Pipes and Fittings



Fume Exhaust Hood 10' x 10' x 13' installed over Rotary Dryers 1954.

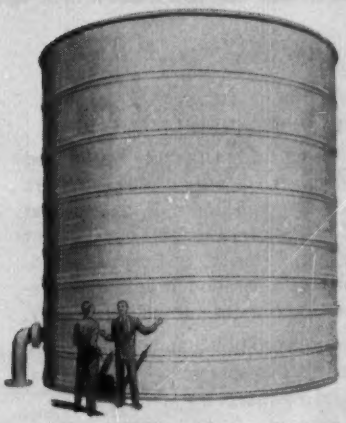


Breaching Assembly for alum manufacture. Installed 1956.

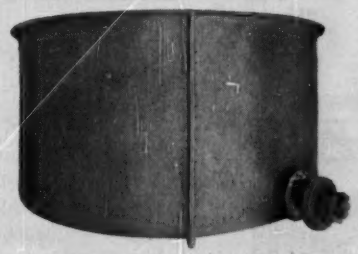


Roof Verti-stacks for corrosive atmospheres. Installed 1954.

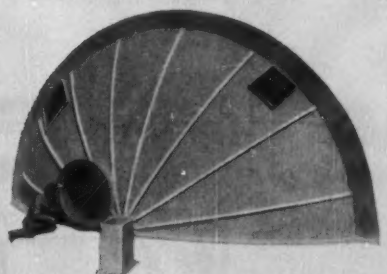
Chemical Storage and Processing Tanks and Covers



20,000 gal. spent sulphuric acid storage tank. Installed 1953.



3-section 7,000 gallon processing tank containing 23% sulphuric acid. Installed 1954.



2-section cover, 25' 8" diameter, with 30" stack outlet for alum manufacture. Installed 1952.

CARL N. CORP. BEETLE PLASTICS

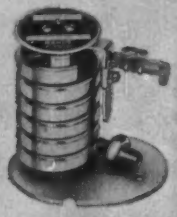
a subsidiary of Crompton & Knowles Corporation

FALL RIVER, MASSACHUSETTS

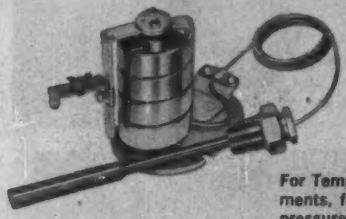
TELEPHONE OSBORNE 7-9464

TYPICAL MOTION-TYPE TRANSMITTER MEASURING ELEMENTS

For Flow and Liquid Level — Type 37 Mercuryless Diaphragm Element. Ranges from 20 to 200 inches water.



For Pressure — Helical Elements, with ranges from 0-200 to 0-6000 psi. Ranges from 10 inches water to 80,000 psi available with other Foxboro pressure elements.



For Temperature—Helical Elements, for liquid filled, vapor pressure, and gas filled thermal systems.

INDICATING TRANSMITTER—MOTION-TYPE

Electronic Transmitter measures flow, pressure, temperature, level, and other variables. Provides local measurement indication directly from the primary element — completely independent of electrical components and power supply. Transmitter uses any standard Foxboro measuring element. No tubes — solid-state components used throughout.

FOXBORO Electronic

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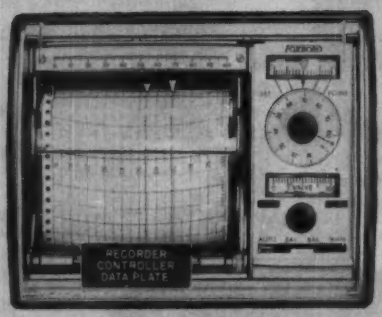


COMBINED RECORDER-CONTROLLER

COMPLETE LINE OF RECEIVING INSTRUMENTS

Electronic Consotrol housing design permits unequalled flexibility in panel arrangement. Recorders and controllers can be enclosed in a 6" x 9" compound unit, as shown at left, or can be mounted separately — recorder in compact 6" x 6" case; controller in one slim 3" x 6" case. Regardless of mounting, controller operation is entirely independent of recorder, and both units pull out separately.

Electronic Consotrol Instrumentation also includes a full line of computing stations, valve actuators, ratio and cascade control systems, and alarms.

for the first time... the 100% solid state electronic system!

- thermocouple and resistance bulb converters–using magnetic amplifiers
- choice of force-balance and motion-type transmitters
- long time-constant tubeless controllers

Consotrol Instrumentation

Electronic Consotrol* Instrumentation—the most complete and advanced family of electronic-operated measurement and control instruments available today! That just begins to describe Foxboro's dramatic new advance in instrumentation. ✓ ✓ ✓ Foxboro electronic transmitters, indicators, recorders, control stations, computing stations, valve actuators and other final operators cover every function in the control loop. All are linked by a d.c. current signal. All are completely tubeless. Even thermocouple and resistance-type systems no longer require vacuum tubes. ✓ ✓ ✓ Electronic Consotrol systems convert temperature, pressure, flow, level measurement, etc., to a proportional signal at the transmitter. Transmission to a remote control station is instantaneous—using an electronic motion-type or force-balance transmitter. Designs are available for both hazardous and non-hazardous areas. ✓ ✓ ✓ Electronic Consotrol Instrumentation heralds a whole new era in process control engineering. Write Foxboro today for the new 32-page Catalog 21-10 which gives full details.

The Foxboro Company, 1012 Neponset Ave., Foxboro, Mass., U.S.A.

*Reg. U.S. Pat. Off.

FOAMGLAS® INSULATION / waterproof, vapor-proof, strong, can't burn, acid-proof, vermin-proof, dimensionally stable

IBM buried its piping problems and saved 50% on installation— thanks to FOAMGLAS insulation

FOAMGLAS insulation makes installing underground piping simpler, less costly. Here's a case in point.

International Business Machines Corporation buried over 7,000 feet of chilled water piping—part of the central air conditioning system at its new San Jose, California, plant. Insulating the piping with Pittsburgh Corning's moisture-proof FOAMGLAS—the unique cellular glass insulation—cut their installation costs in half. Here's how.

Because it is completely impervious to ground water and soil acids, FOAMGLAS will maintain its original insulating value . . . protecting IBM's steel pipe against corrosion. This fact made direct burial of the insulated pipe practical. There was no need for a costly protective concrete tunnel or a pre-sealed conduit to house the pipe. Either would have boosted installation costs from 200% to 300%. FOAMGLAS eliminated this extra cost.

FOAMGLAS is the most dependable—and often the least costly—solution to *your* insulation problems . . . for exposed or buried piping, equipment and plant structures. Write for complete information in our latest industrial catalog.

PC Glass Blocks are another outstanding building product of Pittsburgh Corning Corporation.

Above ground FOAMGLAS insulation insures constant thermal efficiency on IBM's chilled water lines.

Below ground piping gets two-in-one protection—against heat gain and against corrosion—from the sealed glass cells of FOAMGLAS.

PITTSBURGH CORNING CORPORATION

Dept. H-128, One Gateway Center, Pittsburgh 22, Pa.
In Canada: 57 Bloor Street West, Toronto, Ontario

New motor development obsoletes today's application practices!

Only from Allis-Chalmers!

Super-Seal motors save up to 60%

Here's an amazing advance in motor technology! It's the *Super-Seal* motor line—an open motor design so completely unaffected by moisture, dust, dirt, oil, acids and alkalies that it can be used in many applications previously requiring more costly enclosed motors. *Savings range from 15 to 60%.*

Super-Seal motor superiority results from two distinct revolutionary insulating techniques. Available in any integral horsepower size, smaller *Super-Seal* motors incorporate a *Poxeal* stator. A durable epoxy resin encloses the stator, creating an electrical system impervious to outside elements.

In larger sizes, *Silco-Flex* insulation is used. In this system, silicone rubber is vulcanized into a homogeneous mass to form a flexible, moisture and heat resistant, void-free dielectric barrier around coils and leads.

Both of these insulation systems are unsurpassed. Proof? An encapsulated motor ran for hundreds of hours at full load in a 4% brine solution.

Find out more by reading the next pages; then contact your A-C representative or distributor, or write Allis-Chalmers at address shown on back page.

ALLIS-CHALMERS

518 9100

Two revolutionary insulating techniques developed and pioneered by Allis-Chalmers mean savings of millions of dollars for motor users . . .

New open motors are unaffected by moisture and contaminants

Modern insulating materials and new methods of application, now available in *Super-Seal* open-type motors, are drastically changing motor application standards. These insulations are so completely impervious to moisture and contaminants that *Super-Seal* open motors can be used in most applications formerly requiring costly enclosed designs. Existing applications have resulted in savings as high as 60%.

Basic insulation systems

Larger *Super-Seal* motors with form-wound stator coils use the *Silco-Flex* insulation system. Heart of this system is a remarkable rubber-like silicone elastomer, applied in semi-cured state and vulcanized to form a void-free, impervious dielectric barrier. More than four years of development and field testing have proven the superior electrical and physical properties of *Silco-Flex* insulation systems.

Stator coils of smaller random-wound motors are protected by equally effective *Poxeal* insulation system. A tough, durable case of epoxy resin completely seals the winding end turns and slot portions. Bonded to the stator laminations, it forms a seal completely impervious to contaminants.

Moisture resistance

In addition to being void-free, the silicone elastomer used in *Silco-Flex* insulation is moisture repellent. Even in high humidity, moisture does not form a surface film of condensation. Coils with this protection can operate completely immersed in water. In fact, one of the recommended cleaning procedures is use of detergent and water.

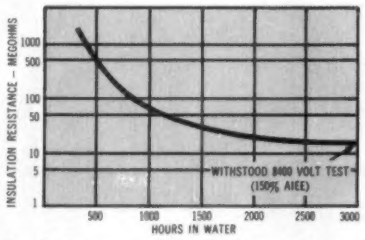


Fig. 1—Test curve shows insulation resistance of *Silco-Flex* insulation while immersed in water.

Moisture resistance of *Silco-Flex* coils is demonstrated in Fig. 1. After more than 3000 hours of total immersion with 2300 volts impressed on the coil, the test was terminated when it became apparent that little more drop could be expected in the coil's insulation resistance. At that point the coil still withstood a high potential test of 8400 volts without injury.

Encapsulated stator windings are equally well sealed. Motors with *Poxeal* insulation protection have been thoroughly tested under water while operating with full load and full voltage.

Resistance to contaminants

Silicone elastomers and epoxy resins are relatively inert to attack by practically all reactive agents. Further, the void-free construction of insulation systems used in *Super-Seal* motors prevents penetration of contaminants. As a result, *Super-Seal* motors are unaffected by oils, most acids, salt solutions, alkalies, and oils and are ideally suited for such applications.

Thermal stability

Temperature-wise, *Silco-Flex* insulation can easily withstand hot-spot temperatures of 200 C and more—

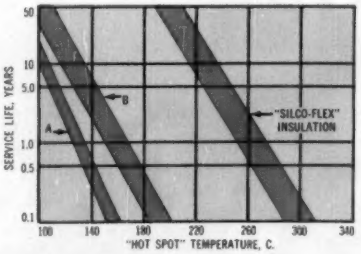


Fig. 2—Chart shows that *Silco-Flex* insulation more than meets Class H requirements.

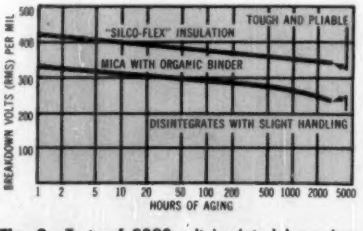
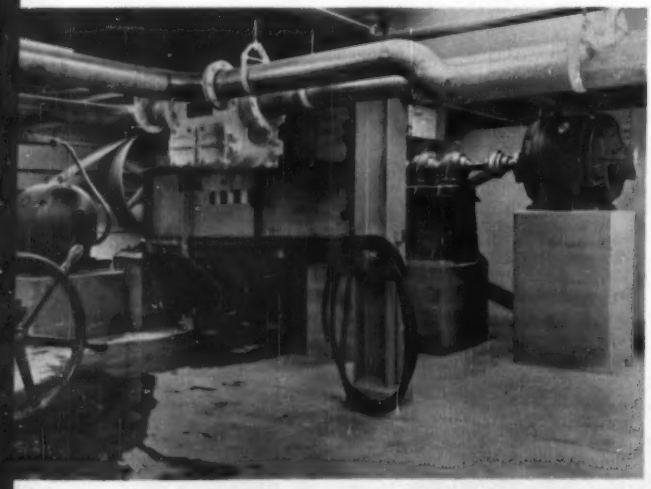


Fig. 3—Tests of 2300-volt insulated bars show thermal stability of *Silco-Flex* insulation.



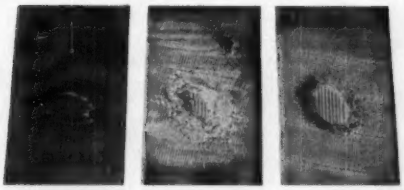
Paper mills have wide application for *Super-Seal* motors because of moist atmospheres.

easily meeting Class H temperature requirements (Fig. 2). At temperatures where the life of Class B coils would be measured in weeks, the life span of *Silco-Flex* coils is well beyond machine obsolescence.

Comparison with a mica-organic binder insulating system (Fig. 3) offers further proof of thermal stability. After 2000 hours of aging at 200 C with 8500 volts applied continuously, the *Silco-Flex* insulated coil was still tough, pliable, and completely serviceable. The mica-taped insulation had deteriorated to the point where it disintegrated readily and was completely useless.

An added advantage of *Silco-Flex* insulation is unusually high thermal conductivity — about twice that of conventional insulations. This means heat dissipates faster from its point of generation.

Poxeal insulation also demonstrates remarkably good thermal stability. Materials now in use are suitable for Class B temperatures, although actual classification of the insulation is determined by the basic material used.



Silco-Flex Insulation | Polyester Mica Tape | Asphaltum Mica Tape

Fig. 4—Samples of motor insulations after sandblasting give comparison of abrasion resistance.

Abrasion resistance

Resistance to abrasion is still another point of superiority in the insulation systems used for *Super-Seal* motors. Abrasion resistance of *Silco-Flex* insulation is compared to other types of insulation in Fig. 4. After one minute of sandblasting with 90-grit aluminum oxide and 100-psi air, only slight surface erosion appeared on the *Silco-Flex* sample. Other insulations were eroded to bare copper.

Application practices obsolete

The superior qualities of *Super-Seal* insulating systems, developed by Allis-Chalmers, make it necessary to reappraise present application practices. With virtually ageless insulation, *Super-Seal* motors assure more reliable service and require less upkeep than the best protected, conventionally insulated machines — and at considerably less cost.

Super-Seal, Poxeal, and Silco-Flex are Allis-Chalmers trademarks.

CHRYSLER KIMBERLY-CLARK GOODYEAR SOUTHERN CEMENT CONTINENTAL CAN SCOTT PAPER AMERICAN OIL CELOTEX HURON PORTLAND CEMEN FORD FIRESTONE PACIFIC GAS & ELECTRIC STANDARD OIL OF INDIANA B. F. GOODRICH DOW CHEMICAL MARLEY INGERSOLL-RAN LINK-BELT

WIDE ACCEPTANCE

of Super-Seal motors proves their advantages

Cement, petroleum, chemical, steel, mining, paper, utilities, municipalities and general industry — outstanding corporations in every field are specifying *Super-Seal* motors wherever operating conditions are tough.

Cost and *superior insulation* aren't the only reasons. Users are getting MORE MOTOR, too. Here's why:

Standard totally-enclosed motors, 55° C rise, have a *service factor of 1.* In other words, "nameplate" horsepower is the maximum. A 40° C rise *Super-Seal* motor with *Poxeal* insulation, and a 60° C rise *Super-Seal* motor with *Silco-Flex* insulation have a *service factor of 1.15.* For comparisons on what this difference means in required motor sizes, see this chart:

Rated Horsepower (Maximum Hp, TEFC)	Maximum Continuous Hp—Super-Seal Motor
15 hp	17.25 hp
25	28.75
40	46
75	86.25
125	143.75
200	230
350	402.5
500	575

Join the swing to *Super-Seal* motors. It will pay dividends fast. Contact your A-C representative or distributor, or write Allis-Chalmers at address shown on back page.

ALLIS-CHALMERS

SOUTHERN CALIFORNIA EDISON LONG ISLAND LIGHTING AVCO UNION BAG UNIVERSAL ATLAS UNION CARBIDE OHIO OIL INTERNATIONAL PAPER SOUTHERN PACIFIC PIPE LINE ALCOA ROHM & HAAS ARMOUR SHELL OIL COMMONWEALTH EDISON OWENS-ILLINOIS WYANDOTTE CHEMICAL BETHLEHEM STEEL ALLEGHENY-LUDLUM DETROIT EDISON MEAD DU PONT ESSO HERCULES POWDER SINCLAIR PIPE LINE GENERAL TIRE MONSANTO

This *SUPER-SEAL* MOTOR application SAVED $3000!

Find out how much you can save

This application of a *Super-Seal* open-type motor — in place of a weather-protected design of the same rating — *saved the user $3000.00!*

You can achieve similar savings! Fill out the data sheet below and *find out for yourself how much you can save — on a "no-strings-attached" basis.*

Here's what to do: 1) Select an enclosed motor application in your operations (a new motor need or, for comparison, a motor just purchased); 2) fill out the data sheet; 3) mail to the address shown.

We'll give you a cost quotation on a *Super-Seal* open motor for that application.

Fill out this data sheet—

no strings attached—to find out how much you can save on a new motor or on an existing motor installation

To: **ALLIS-CHALMERS**
888 S. 70th St., Milwaukee 1, Wis.

Motor Data

1. Type (i.e., squirrel cage):
   .....
   Horizontal ☐ Vertical ☐
   Hp..... Rpm.....

2. Phase..... Frequency.....
   Voltage.....

3. (For synchronous only)
   Power factor.....
   Starting torque.....
   Pull-in torque.....
   Pull-out torque.....

Application Data

4. Description of application:
   .....
   .....
   .....
   .....
   .....

5. Drive: Direct-connected ☐
   V-Belt ☐ Other:.....
   .....
   Starting load.....
   Ambient temperature.....

6. Operating conditions:.....
   .....
   .....
   Dirty ☐ Clean ☐ Wet ☐ Dry ☐
   Other.....

Information on Existing Motors
(for comparison)

7. Type of insulation
   .....
   Type of enclosure
   .....
   Time rating.....
   Temperature rise.....
   Bearings:
   Anti-friction ☐ Sleeve ☐

8. Special characteristics or construction:
   .....
   .....

NAME.....

TITLE.....

COMPANY.....

ADDRESS.....

A-5869

ALLIS-CHALMERS

Using Salt Efficiently

by INTERNATIONAL SALT COMPANY, INC.

How to Measure Brine Strength on Different Hydrometer Scales

The most common method of measuring brine strength in industry is to use some type of hydrometer. Every hydrometer sinks into a liquid until it has displaced a weight of the liquid equal to its own weight. The scale divisions on a hydrometer are not usually of equal length, since the volume of displaced liquid increases as more of the stem is immersed.

Using a hydrometer is a relatively simple process—but reading the hydrometer scale is complicated by this fact: the scale may vary from plant to plant because hydrometers may be used to measure strength of other liquids, as well as salt brine. To help clear up any possible confusion, here are an explanation and a comparison of the five most common hydrometer scales used for measuring brine strength.

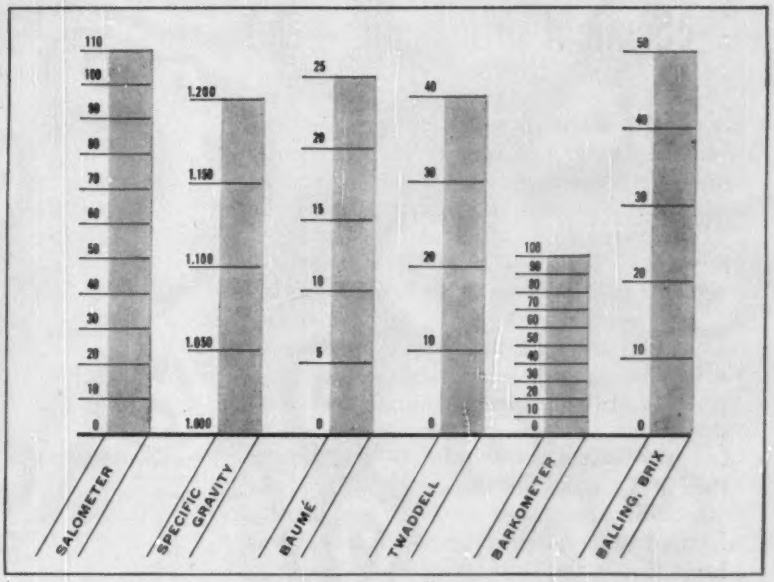
SALOMETER SCALE. This is by far the most common of all the hydrometer scales used for testing brines. The scale indicates directly the per cent saturation of the brine, reading 0° S. in pure water, and 100° S. in fully saturated brine. The salometer uses the values of Gerlach, meaning that 100%-saturated brine contains 26.395% salt by weight. Each salometer degree, then, represents 0.2639% salt.

The salometer reading expresses the per cent of saturation. Thus, a brine of 40° S. strength is 40% saturated, and contains 40% of 26.395%, or 10.558% salt by weight.

SPECIFIC GRAVITY SCALE. This reads the specific gravity of the brine *directly*. These hydrometers may be obtained with the entire length of scale covering a limited range of specific gravities, thus permitting great accuracy.

BAUMÉ SCALE. This scale was originally intended to have each degree equal a per cent of salt in the brine. But this is now only a rough approximation. The Baumé scale reads 0° Bé. in pure water, 24.6° Bé. in fully saturated brine. Also, a factor of "modulus" is needed to translate degrees Bé. to specific gravity, since the scale divisions are of equal length. This modulus has been standardized at 145, so that degrees Bé.=145–145/sp.gr.

TWADDELL SCALE. Named after its inventor, the Twaddell scale reads 0° Tw. in pure water, 40.8° Tw. in fully saturated brine. Each increase of 0.005 in specific gravity causes 1° increase on the Twaddell scale. Thus, the number on the right of the decimal point of the specific gravity, divided by 5, is the degrees Tw. For example: 1.140 sp.gr. is 140/5, or 28° Tw.



COMPARISON OF COMMON HYDROMETER SCALES

(Chart gives quick, visual relationships of readings on the salometer scale to readings on other scales.)

BARKOMETER SCALE. Used extensively for testing tanning liquors, the Barkometer scale reads 0° Bk. in distilled water, and 204° Bk. in fully saturated brine. Each increase of 0.001 in specific gravity causes 1° increase on the Barkometer scale. Thus, the number on the right of the decimal point of the specific gravity is the degree Bk. For example, 1.025 sp.gr. is 25° Bk.

The hydrometer scales described above are usually calibrated for brines at 60°F. temperature. When testing brines at other temperatures, it's necessary to make certain corrections...or to use a specially designed hydrometer. You can get a table showing proper temperature corrections, plus other data on measuring brine strength, from International Salt Company.

Using salt in its many industrial applications calls for technical knowledge and experience. International Salt Company has both—plus a continuing program of research and development in salt. These things can be put to work for you . . . in your plant . . . to help you get the most out of the salt or brine you use.

INTERNATIONAL SALT CO., SCRANTON, PA.

Sales Offices: Atlanta, Ga.; Chicago, Ill.; New Orleans, La.; Baltimore, Md.; Boston, Mass.; Detroit, Mich.; St. Louis, Mo.; Newark, N. J.; Buffalo, N. Y.; New York, N. Y.; Cincinnati, O.; Cleveland, O.; Philadelphia, Pa.; Pittsburgh, Pa.; Memphis, Tenn.; and Richmond, Va.

Service and research are the extras in STERLING SALT
PRODUCT OF INTERNATIONAL SALT COMPANY, INC.

QUALITY REFRACTORIES

by HARBISON-WALKER serve every chemical processing need

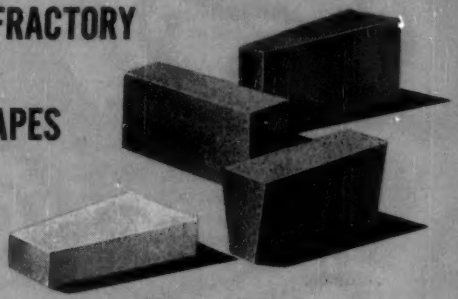
HARBISON-WALKER products comprise the specific types and classes for each particular purpose. Included are the widely diversified monolithic materials, refractory brick of the entire alumina-silica series and high alumina brands of all classes from 50% to 99+% alumina content. From these can be selected the kinds which best fulfill all the special requirements for maximum corrosion resistance to various sulphur compounds and hydrocarbons and to the severe fluxing effect of oil ash in high temperature furnace operations. Harbison-Walker refractories of the various types and classes are especially adapted for withstanding excessive abrasion and erosion and the disintegrating action of reducing atmospheres through critical temperature ranges.

GUN APPLICATION — For many installations, Harbison-Walker castables are used to best advantage with various types of air placement guns.

TROWELLING—This method is preferred for some applications and the excellent working qualities of Harbison-Walker castables make them easy to use and to secure uniform durable linings.

Write Technical Service Department regarding the selection of the refractories best suited for your specific applications.

H-W REFRACTORY BRICK AND SHAPES



Fireclay Brick—All Classes • High Alumina Brick —All Classes from 50% to 99% alumina • DURO and W-ACID, acid-proof brick, floor tile and • DURO tower packing rings and grid tile • Silica Brick • Basic Brick—All Classes

World's Most Complete Refractories Service

H-W CASTABLE REFRACTORIES and other monoliths

CASTABLES (all classes) · PLASTIC FIRE BRICK (all classes) SPECIAL GUN MIXES · TROWELLING MIXES

These monolith-forming refractories are widely used in chemical processing, petroleum refining and petro-chemical industries. They are available in all the many commercial classes which provide the most desirable combinations of physical and chemical properties for each particular requirement. Among these, several which are most widely used with special benefit are briefly described in the following.

HARCAST is exceedingly strong and resistant to reducing conditions at operating temperatures and meets rigid specifications used in the chemical processing industries. Its composition and low permeability greatly retards corrosion by gases under high pressures. It is used in severe erosion areas. The approximate service limit is 2800°F.

H-W 56 LIGHTWEIGHT CASTABLE combines light weight with high insulating value and strength to the utmost degree. Produced also with a very low ferric oxide content of less than 0.5%, it provides maximum resistance to reaction with various gases. Among important applications are refinery vessel linings, ducts and breechings, boiler back wall and tube decks, air preheater linings, furnace walls, roofs and doors. The approximate service limit is 2100°F.

H-W EXTRA STRENGTH CASTABLE is exceptionally strong and withstands severe abrasion and erosion at temperatures up to its service limit of 2400°F.

HARCHROME is a special chrome castable which is second to none for abrasion resistance for the range of operating temperatures prevailing in feed lines.

H-W HIGH ALUMINA CASTABLE is made with high alumina base raw materials and a very pure hydraulic setting binder. Its approximate service limit is 3000°F. A 3200°F. service limit material is also available, made with crystalline alumina base. These castables, due to extreme purity and low permeability, are especially suited for use in highly reducing atmospheres.

TYPICAL CASTABLE CONSTRUCTION

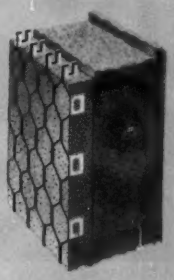
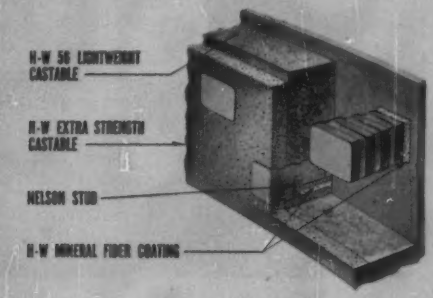


Illustration shows H-W 56 Lightweight (Insulating) Castable next to the shell with H-W Extra Strength Castable superimposed in hex-steel for working lining.



Typical arrangement of refractory anchor method for monolithic linings. H-W Mineral Fiber Coating provides insulation for metal stud.

H-W MORTARS

These include a wide variety of both hot and cold-setting cements which fulfill the requirements for laying all the different kinds of refractory brick. Some leading brands are HARWACO BOND, THERMOLITH and KORUNDAL BONDING MORTAR which provide the requirements for laying the alumina-silica and high alumina refractories ranging up to 99% alumina content.

HARWACO MASTIC

This plastic cold-setting monolithic refractory has a working consistency similar to that of stiff putty and is ideally suited for plastering with a trowel, as for example, for sealing V-shaped spaces at the exterior face of tangential tubes.

H-W INSULATING REFRACTORIES

Included are seven classes of insulating fire brick, having service limits of 1600°F. to 3000°F; mortars for laying insulating brick; several brands of castable insulating refractories; H-W BLOCK INSULATION; H-W FINISHING CEMENT; and H-W MINERAL FIBER COATING.

HARBISON-WALKER REFRACTORIES COMPANY AND SUBSIDIARIES

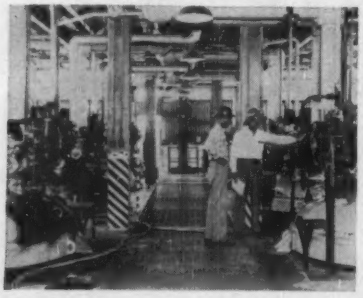
General Offices: Pittsburgh 22, Pennsylvania

Plants, Warehouses and District Sales Offices in many cities and states

PFAUDLER

How Diamond Alkali uses Glasteel to cut turnaround time and protect purity at its PVC plant

Like most polymers, polyvinyl chloride gets so sticky in process that it gums up equipment surfaces to the point that a general clean-out is usually required after each batch.



Wishing to avoid such unproductive, unprofitable time at its new Deer Park, Texas, plant, the Diamond Alkali Company instructed its engineers to run comparative tests on materials of construction.

Pfaudler Glasteel was the final choice and Diamond Alkali uses it wherever possible in the new plant . . . for polymerizers, blow-down tanks, storage and receiver tanks, and even for pipes and valves.

So little of the PVC clings to the smooth glassed surfaces of this equipment, a simple fast flush is all that's necessary to keep it in process condition.

During two years of operation, on a twenty-four hour a day basis, production has been halted only for routine maintenance.

Protects purity too

Pfaudler Glasteel is chemically inert to the ingredients and catalysts used in making PVC . . . so there can never be any contamination of Diamond Alkali's product.

Special agitator seals on the polymerizers prevent any lubricants from bleeding into the product.

The equipment is so designed and controlled that Diamond Alkali can hold temperatures to within ½° F. of a desired setting.

If you would like to know more about Pfaudler Glasteel and the equipment made with it, check the coupon for our Bulletins 968 and 932.

Big zirconium and titanium heat exchangers now available

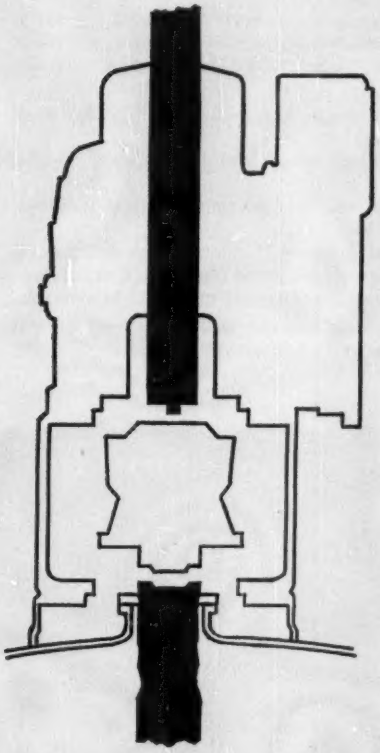
Recently Pfaudler added vacuum-purge inert gas welding to the already established flow-purge welding chamber shown below. This places Pfaudler in the advantageous position of offering the most advanced facilities for welding titanium and zirconium. Several hundred square feet of heat transfer surface can be produced economically and rapidly.

Add these metals to your list of available Pfaudler materials for fighting corrosion in process equipment—an ever-growing list that already includes Glasteel, stainless steel, Hastelloy, nickel, Inconel, and Monel.

The unit being worked on in the picture is one of the largest zirconium exchangers built to date, having 134 square feet of heat transfer area. Sixty-four 1" O.D. 18 gauge seamless zirconium tubes in a 21" O.D. shell 8' long. Designed for 75 psi and 350°F., it forms the calandria section of an evaporator for concentrating hydrogen peroxide solutions.

Pfaudler Bulletin No. 949 describes the complete line of metal and alloy heat exchangers. Heat transfer equipment of Glasteel construction is covered in Bulletins No. 921 and No. 886. Send the coupon for copies.

CORROSIONEERING NEWS



With Pfaudlerpac you can change a seal or stuffing box in minutes

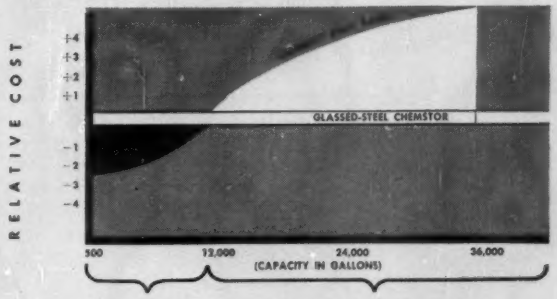
Pfaudlerpac seals and stuffing boxes come to you as pre-assembled, pretested units ready for installation.

On our new BH Drive you can change these seals and stuffing boxes *without* entering the vessel, removing the drive, or disturbing alignment.

Pfaudlerpac Seals are especially recommended for service in high temperatures or pressures, and where vapors are highly corrosive, explosive, or toxic. They are rotary types with glassed sleeves which eliminate the dangers of metallic contamination or corrosion.

Pfaudlerpac Stuffing Boxes are economical units for use in moderate temperatures and pressures. They are the non-rotary type with Hastelloy shielded sleeves. Glassed or alloy shoulders with Teflon gaskets prevent corrosion from reactor vapors.

For more information on Pfaudlerpac, check the coupon for Bul. 972.



If you store this much of chemicals like these . . .

Acetic acid	Chloroform
Aluminum chloride	DDT
Aluminum sulfate	Ether
Ammonium thiocyanate	Ethylene glycol
Ascorbic acid	Formaldehyde
Benzene	Hydrochloric acid
Benzyl chloride	Nitric acid
Butyl alcohol	Phenol
Bromine	Phosphoric acid
Caustic soda	Phosphorus oxychloride
Chlorine dioxide	Potassium sulfate
Monochlor-acetic acid	Sodium chlorate
	Sulfuric-acid
	Thionyl chloride

then the price of Chemstor glassed-steel tanks tells only half the story. Subtract from this price the extra years of service which only glassed steel can give you with so many corrosives. As a point of fact, only hydrofluoric acid and fairly harsh alkalies have any appreciable corrosive effect on Chemstor tanks.

If you store this much of practically anything . . .

then you'll want Chemstor glassed-steel tanks simply on a price basis. You can pocket the extra years of service life given by glassed steel as a sort of dividend.

Some other facts about Chemstor tanks

Smoother than even the most highly finished metal or plastic, Chemstor tanks are ideal for sticky storage; they discourage clinging, scale, and product build-up like any glass container.

Chemically inert glass is all that ever touches your product in a Chemstor, so you never need worry about contamination or influence on your product's flavor, color, etc.

Surprisingly strong, glass bonded to steel is actually a very rugged material. Chemstor tanks require only sensible handling and maintenance to insure long years of service.

Write for Bulletin 918 for more information.

PROCESS EQUIPMENT by PFAUDLER
a division of **PFAUDLER PERMUTIT INC.**
Dept. CE-128, Rochester 3, New York

Please send me: ☐ Bul. 968 Buyer's Guide to Corrosion Resistant Process Equipment; ☐ Bul. 932 Polymerizers; ☐ Bul. 949 Heat Exchangers; ☐ Buls. 921 and 886 Glasteel Construction; ☐ Bul. 972 BH Drive; ☐ Bul. 918 Chemstor Tanks

NAME.....

TITLE.....

COMPANY.....

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CITY..... ZONE..... STATE.....

See Chemical Engineering Catalog, pp. 1407-1418 for complete Pfaudler line.

Building Structures for the PETROCHEMICAL INDUSTRY is a specialty and an art . . .

Petrochemicals have come a long way since the wooden storage barrels used in the early days. Increasingly complex refinery processes have created demands for storage vessels and process equipment which can be met only by the most exacting attention to materials, design, fabrication and erection.

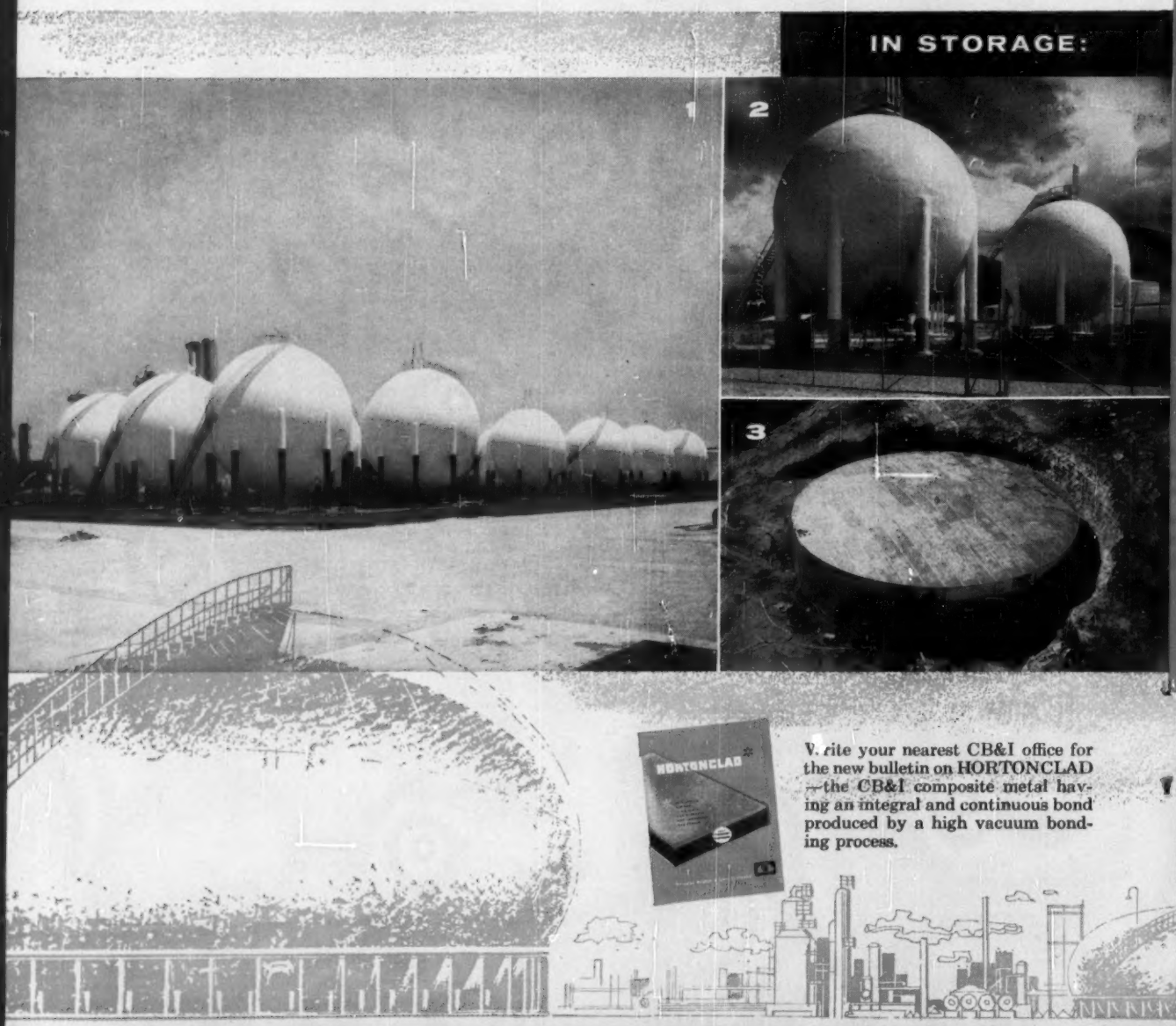
Over the years, the ability of CB&I to provide a single, responsible and *coordinated* facility for these services has been reflected three ways:

1 In the *performance* records of CB&I-built refinery structures in service throughout the world.

2 In an increasing *demand* for CB&I's services and the applied metallurgical facilities which have made these performance records possible.

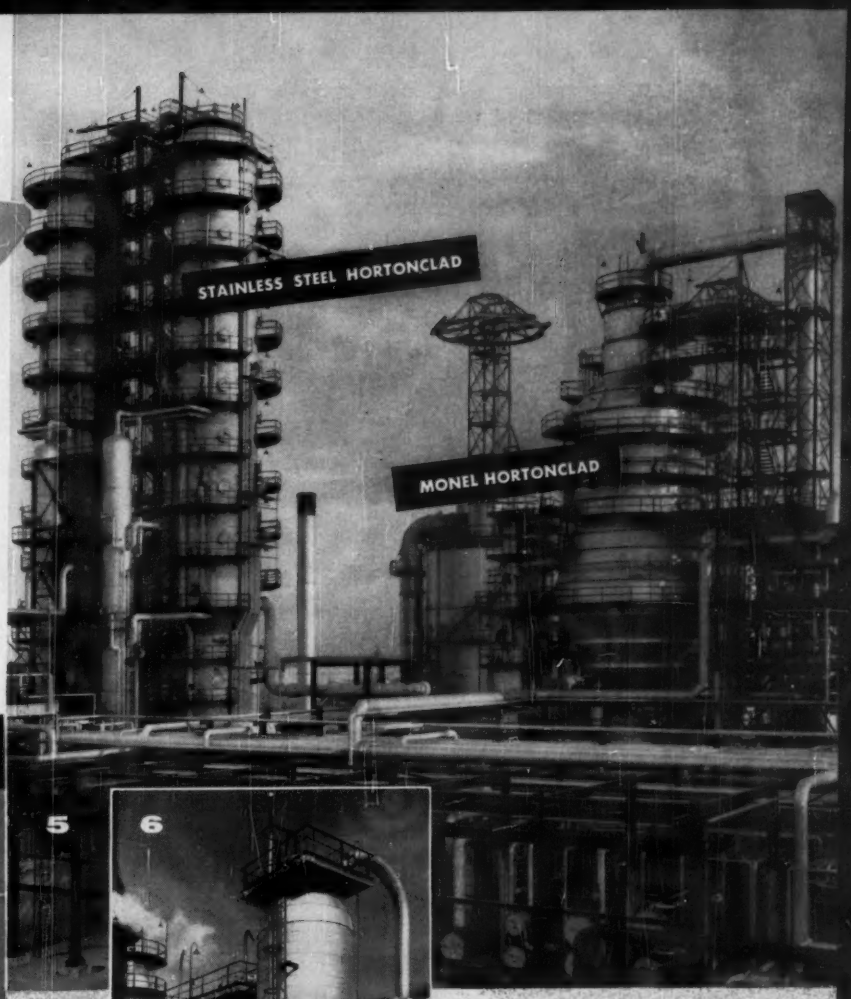
3 In CB&I's stepped up *program of metallurgical progress* . . . aimed at developing better fabrication, welding and testing procedures—which have placed new corrosion-resistant metals and alloys, such as Hortonclad® at the disposal of CB&I customers.

This is why—wherever chemical or petroleum products are processed or stored, you'll find CB&I *Craftsmanship in Steel*. For further details write your nearest CB&I office for the bulletin: *CB&I Special Plate Structures.*

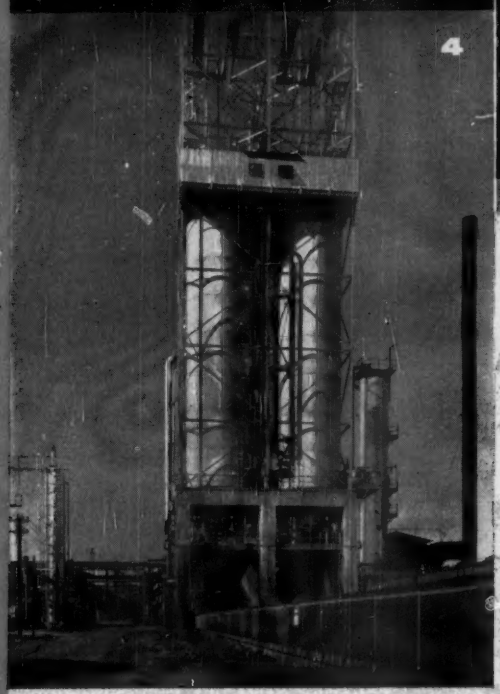


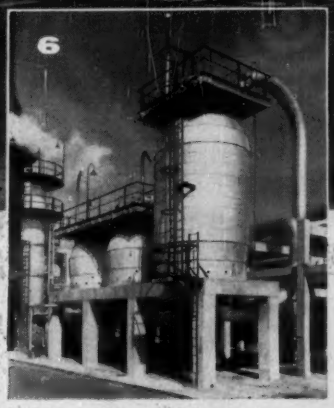
Write your nearest CB&I office for the new bulletin on HORTONCLAD —the CB&I composite metal having an integral and continuous bond produced by a high vacuum bonding process.

. . . with CB&I



OR PROCESSING:





1 **PRESSURE VESSELS.** CB&I furnished 19 Hortonspheres® through the Flour Corporation, for the multi-million dollar *Texas Butadiene and Chemical Corporation* plant near Houston, Texas.

2 **T-1 STEEL** construction makes it possible for these two Hortonspheres to do the work of 20 mild steel tanks . . . in propane service—*Compania Shell de Venezuela.*

3 **WORLD'S LARGEST ALUMINUM TANK.** Stores 82% corrosive ammonium nitrate . . . is 164 ft. in diameter and 24-ft. high.

4 **COKING CHAMBERS** of stainless steel Hortonclad were fabricated and erected by CB&I at a Kansas Refinery.

5 **HORTONCLAD.** 124-ft. high crude columns (left) and 125-ft. vacuum column (right) were partially clad using stainless steel and monel Hortonclad.

6 **HOUDRIFORMER.** Three CB&I-built reactors are used in high severity reforming process unit—to convert low octane naphtha into high octane blending stocks. Plate thickness is 5 inches.

C42SCB

Chicago Bridge & Iron Company

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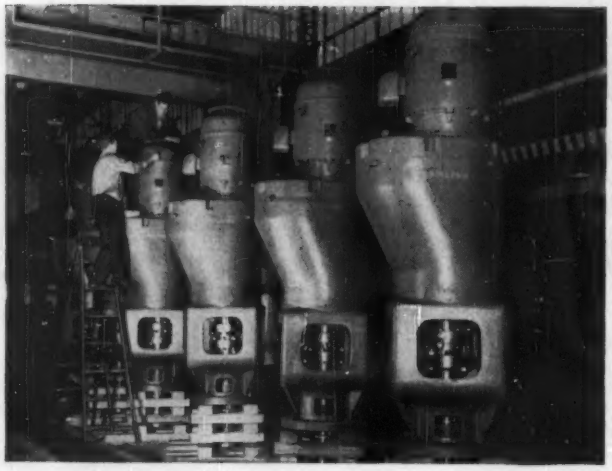
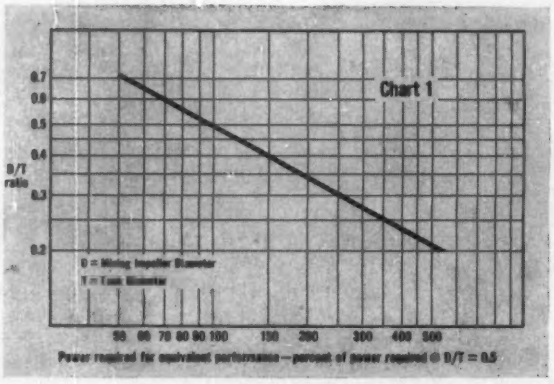


Q. In larger mixing operations, what are the economics of buying mixers that match requirements *exactly* compared to buying mixers having an adequate margin of torque capacity?

A. As mixing operations are scaled up and fluid mixers required increase in size, the cost per unit drive torque capacity decreases rapidly with the increase in drive size. It becomes poor economy not to maintain an adequate level of torque applied to the mixing operation. Consider also that agitators and auxiliaries rarely represent more than a small percentage (2-4%) of the plant investment . . . yet maintenance costs on the more difficult operations can run as high as 15% or 20%. If down time is considered, then costs can run many times these figures. Obviously, there is no economy in drives and components such as shafts which *just* meet requirements.

it's questions like these... that bring out the facts in buying mixers...



Q. Are "dollars per horsepower" a valid basis for comparing mixer values?

A. No. Mixers having the same horsepower rating and drive efficiency can vary widely in torque rating. Torque applied to the mix is what does the work and torque is what you pay for. When comparing mixer values, the most important first step is that of developing torque ratings of alternate units offered. Using the most familiar units, torque can be calculated as follows:

$$\text{Torque (lb. inches)} = \frac{63025 \times \text{Motor HP}}{\text{Mixer shaft RPM}}$$

The mixer having the lower torque rating must use a higher mixer shaft speed and smaller diameter impeller to maintain a given HP level. This can lead to unsatisfactory performance. However, a mixer of equivalent horsepower rating but with a higher torque rating and larger impeller will do the job well. For an idea of the importance of impeller size, the chart shows the influence of impeller diameter in relation to tank diameter (D/T ratio) upon motor required to obtain a specific level of performance in many industrial mixing operations. The bigger impeller at the slower speed (higher applied torque) will be a sounder choice.

YOU GET MORE FOR YOUR FLUID MIXER DOLLAR
Because We Design and Build The *Whole* Unit

It's simple economics! Philadelphia Mixer is the only manufacturer that designs and builds the complete unit. Because we control production and costs, we can afford to give you more mixer per dollar. For example:

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You don't pay a premium for these extras—or for the better performance and longer life of a Philadelphia Mixer. You get them as a bonus.

You can select your Philadelphia Mixer from six standard models. 1 to 200 HP. Special units to 500 HP. Horizontal motor or vertical motor drive. Mechanical seal or packed stuffing box. Paddle or turbine type impellers.

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U.S.I. CHEMICAL NEWS

Dec. ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1958

Sodium Reduction Process Yields High-Purity Zirconium and Titanium

Outstandingly pure zirconium and titanium metals are being produced by means of a U.S.I.-developed sodium reduction process at the new Ashtabula plant of Mallory-Sharon Metals Corp.

Eighty per cent of the usual impurities in zirconium do not show up in spectrographic analysis of the sodium-reduced metal. Measurements of Brinnell Hardness Number, another indication of purity, show that the sodium-reduced zirconium has a value as low as 90-95, compared with about 70 for crystal bar zirconium — the industry's purity standard — and about 130 to 150 for metal produced by the magnesium reduction process.

The sodium reduction process has the additional advantage of low cost. Zirconium can be produced by this method for less than any other means. The process for crystal bar zirconium is too expensive to make the material competitive. The magnesium process costs

MORE

"Impossible" Alloys Now Made by Bombardment

In laboratory work sponsored by the Air Research and Development Command, normally incompatible metals are being combined by a new, high-temperature, high-speed bombardment technique. Microscopic particles of one metal are propelled by a "solid linear accelerator" to speeds of over 50,000 mph, and inserted into the crystalline lattice structure of the other metal.

Researchers believe that this new technique can be used to give materials new properties or to combine the desired properties of several materials. Aluminum alloyed with iridium particles to give it better high-temperature characteristics is cited as one example.

U.S.I. Products, Plants Detailed in New Brochure

The chemical industry can now get a complete picture of U.S.I. activities through a new company brochure available on request. This 40-page, full-color booklet covers:

- U.S.I. growth over the past eight years
- plans for the future
- affiliations with other companies
- products and where they are used
- type, number and location of plants
- research facilities
- sales service facilities

For your copy of "National Distillers and Chemical Corporation Expands in the Chemical Industry," address the U.S.I. Advertising Department on your company letterhead.

Chemical Makers Complete First Year of Continuous Promotion Of the Industry to the Public

Chemical Industry Activity Committees of MCA Report Growing Progress on Local Level, Both in Participation by Chemical Companies, and in Response by the Community.

In January the Chemical Process Industries will begin the second year of a continuous cooperative public relations effort sponsored by the Manufacturing Chemists Assn. and carried out through local Chemical Industry Activity Committees (CIAC). This first year has been one of organization and idea-testing, combined with a gradual building up of local activity.

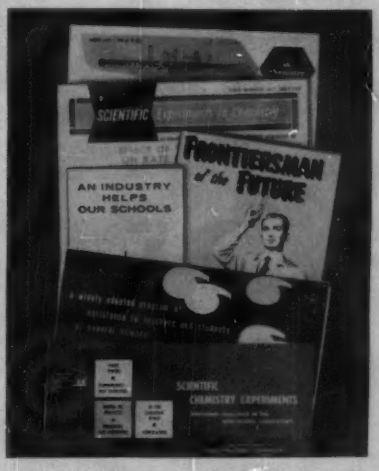
The program is now in operation in at least 380 communities and areas in 45 states. About 900 individuals in 150 companies are now equipped to work closely with local educational institutions, the press, radio and TV, community groups, organizations and clubs to acquaint the American public with the importance of chemistry in daily life.

The continuing program has been a natural outgrowth of the four Chemical Progress Week efforts. To quote General Hull, president of MCA: "Active . . . committees in a number of areas, believing that their community relations problems . . . were year-round and that they had an effective organization, have established continuing committees and have proposed that MCA sponsor a national program . . ."

Objectives of the Program

MCA feels that greater public understanding of the benefits of chemistry will also benefit the chemical industry. By building a good reputation for the CPI, MCA hopes to create a community climate of welcome for chemical enterprise, to achieve rapid acceptance of new products, and to attract top talent and more capital to the industry.

MORE



Samples of educational aids supplied by MCA.

New Synthetic Rubber Made with Deuterium

Claimed more rubbery than rubber itself, a new experimental compound — cis,1,4-polyisoprene in which all hydrogen has been replaced with deuterium (heavy hydrogen) — is being studied for explanations of the elasticity and other properties of ordinary rubber.

The new deuterio rubber seems to be more elastic, apparently because the molecules containing deuterium atoms have less attraction for each other than molecules containing hydrogen. It is naturally heavier due to the presence of heavy hydrogen. It does not need carbon black for high tensile strength.

Studies of its behavior may explain, among other things, why rubber gives up and takes up heat during deformation and recovery, and may throw some light on the infrared absorption and crystallization of rubber.

Polyethylene Membranes Extend Polarographic Analysis to Gases

It is now possible to analyze gases by polarography, without dissolving them in a liquid, by introducing a semipermeable membrane between gas and electrode. The membrane substitutes for the liquid both as a diffusion layer and as an electrical contact. Polarographic current is directly proportional to the partial pressure of the gas.

Studies so far show that polyethylene is the best membrane material. Consequently, a cell consisting of a platinum working electrode, polyethylene membrane, and a salt bridge to a saturated calomel reference electrode, has been used in most of the research work to date. The cell will analyze oxygen or sulfur dioxide in concentrations from 100% down to 50 ppm, and should be suitable for continuous analysis and control of process streams, among other applications.

Other advantages of the polyethylene membrane: it prevents fouling of electrode surfaces; it is impermeable to ions and so eliminates interferences by reducible ions in the sample.

Dec. ★ **U.S.I. CHEMICAL NEWS** ★ 1958

CONTINUED

Chemical Promotion

What the Program Consists of

Well supplied with ideas and materials by MCA, the local committees have been exploring all possible avenues of communication.

Speakers Bureaus have been set up to contact local religious, educational, social, civic, business and other groups who would be interested in chemistry as it relates to their working and living experiences. These bureaus arrange for speakers and engagements, and supply material as needed.

Press Relations have been established with all newspapers to keep them informed on local happenings and general trends in the CPI.

Radio and Television people interested in material or personalities of local significance have been contacted. Resulting programs have included interviews, panel shows on local issues, broadcasts of special events, and educational and public service films.

Community Participation by the CPI in such events as fund drives, county fairs, chamber of commerce activities and civic improvement committees has been encouraged.

Direct Mail of MCA's Chemical News and other appropriate information to "opinion leaders" in the community has been undertaken.

Educational Activities have been voluminous. MCA has prepared comprehensive material to aid teachers and students. Industry-education meetings are held widely. Special workshops and seminars, essay contests, awards, scholarships and fellowships, study programs, guest lecturers, and so on and so on, have been set up.

More companies are joining in the second-year effort as direct benefits in terms of industry-community good-will become apparent.

More information is available from MCA Chemical Industry Activity Committees, 1625 Eye St. N.W., Washington 6, D.C.

CONTINUED

Sodium Reduction

more to operate also and the zirconium does not have the purity advantage.

Sodium-reduced titanium is making an impressive showing too. All of the first month's production at Ashtabula was blended and shipped as specification metal.

The purity achieved by sodium reduction can be attributed to several factors. The sodium, shipped from U.S.I.'s Ashtabula plant, is kept clean under argon blanketing. Brittleness is minimized in the resulting metals because oxygen and nitrogen are kept out.

Low-melting sodium can be handled as a liquid and therefore filtered and stored in the absence of air. As a liquid, it can be accurately pumped, metered and controlled. It does not alloy with zirconium or titanium.

Polyethylene "Rosettes" Ideal as Tower Packing

The Army Corps of Engineers has found that helically-wound polyethylene strip formed into toroidal "rosettes" makes a lightweight, sturdy, highly efficient packing for cooling towers. These polyethylene "rosettes" give 20-40% greater cooling efficiency at a pressure drop only 35% that of conventional packings of equivalent size. In addition, they are corrosion-resistant—unaffected by water and highly corrosive chemicals.

Used by the Army in a trailer-mounted water cooling tower — part of a mobile carbon dioxide generating plant — the polyethylene packings not only resist completely the shock of rough riding, but also cut down on the weight which must be transported. They weigh 10 lb./cu. ft. By comparison, fragile ceramic Rashig rings and Berl saddles of equivalent size weigh 48 and 45 lb./cu. ft. respectively.

Polyethylene "rosette" packings for cooling towers (photo courtesy Harshaw Chemical Co.).

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Stannic sulfide, a gold-colored powder with talc-like consistency, is now offered in pilot quantities. Suggested for use in varnishes and lacquers to gild and bronze wood, metal, paper. **No. 1420**

Polyethylene bottles with rotating sleeve to protect label are now on market. Horizontal channels for sleeve are molded around bottle. Label is inserted through vertical opening in sleeve, is held by channel, protected by sleeve. **No. 1421**

Natural vegetable hydrocolloid now available as coagulant aid, filter, selective ore flocculant is claimed nontoxic and edible, safe for use in settling drinking water, clearing waste water before return to earth or streams. **No. 1422**

Nuclear reactor experiments are described in new book now being sold. Prepared by staff of Argonne Nat'l. Labs., volume outlines problems of design, construction, operation of reactors; gives details of equipment and experiments. **No. 1423**

New aqueous base dispersant for uncured liquid epoxy and polyester resins is being marketed. Is solvent-free, noninflammable. Said to facilitate removal of residual resins from molds and equipment. **No. 1424**

Dry chemical fire extinguisher now available is claimed to deliver a 15- to 20-foot stream of fire-killing, heat-absorbing powder over a 60° arc. Powder is nontoxic, will not freeze, corrode or conduct electricity. **No. 1425**

New caulking compound, claimed both thermosetting and thermoplastic, is based on co-vulcanization of new synthetic elastomer with asphaltic compound. Said to be permanently flexible from -30 to 165°F. Adheres to all surfaces. **No. 1426**

New bench model infrared spectrophotometer has KBr prism, permits chemical analysis in the 12.5-25 micron region. Yields more complete quantitative and qualitative information on structure of compounds such as aromatic HCs. **No. 1427**

Water-thinned contact cement for plastic laminating and other rapid assembly work is now available. Contains no flammable solvents and is claimed completely safe. Said to produce instant, strong, creep-resistant bonds. **No. 1428**

Disposable polyethylene syringe for applying adhesives, potting compounds, etc. can now be obtained. Said to deliver exact quantities of fluid without flooding, starving or dripping. Capacity about 10 cc. of fluid. **No. 1429**

PRODUCTS OF U.S.I.

Alcohols: Ethyl (pure and all denatured formulas); Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL® M, ANSOL PR.

Organic Solvents and Intermediates: Normal Butyl Alcohol, Amyl Alcohol, Fusel Oil, Ethyl Acetate, Normal Butyl Acetate, Diethyl Carbonate, DIATOL®, Diethyl Oxalate, Ethyl Ether, Acetone, Acetoacetanilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, ISOSEBACIC® Acid, Sebacic Acid, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P., Pelargonic Acid, 2-Ethyl Heptanoic Acid.

Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Riboflavin USP, Intermediates.

Heavy Chemicals: Anhydrous Ammonia, Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions, Phosphatic Fertilizer Solution, Sulfuric Acid, Caustic Soda, Chlorine, Metallic Sodium, Sodium Peroxide, Sodium Sulfite, Sodium Sulfate.

PETROTHENE® Polyethylene Resins

Animal Feed Products: Antibiotic Feed Supplements, BHT Products (Antioxidant), Calcium Pantothenate, Choline Chloride, CURBAY B-G®, Special Liquid CURBAY, VACATONE®, Menadione (Vitamin K_3), DL-Methionine, MOREA® Premix, Niacin USP, Riboflavin Products, Special Mixes, U.S.I. Permadry, Vitamin B_{12} Feed Supplements, Vitamin D_3, Vitamin E Products, Vitamin E and BHT Products.

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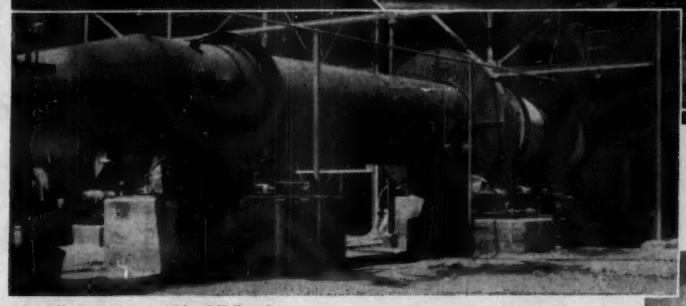
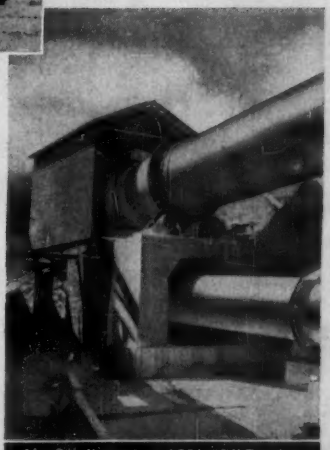


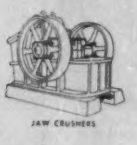
7'—0" diameter x 60'—0" Traylor Rotary Slaker in chemical processing plant.

For over half a century Traylor-Made Machinery has helped some of the process industries to satisfy the demand for greater production. Constructed by master craftsman, Traylor equipment incorporates many design and engineering innovations that make Traylor rotary kilns, coolers, dryers and slakers the choice of engineers and operators. For information on these fine Traylor-Made products write for bulletin number 1115 today ! !



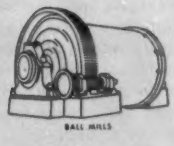
6'—0" diameter x 120'—0" Traylor Rotary Kiln with a 3'—0" diameter x 36'—0" Traylor Rotary Cooler in a lime plant.

SECONDARY GYRATORY CRUSHERS



JAW CRUSHERS

PRIMARY GYRATORY CRUSHERS



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Traylor

Giant Molecules

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COAL CHEMICALS IN THE HOME add convenience, comfort, and pleasure. Refining of Tar permits its use in paints, roofing, and insulating materials. Naphthalene is familiar in the form of moth balls, but it is also important in making synthetic enamels that keep products new looking longer. Benzol is used in making plastics for housewares, floor tiles, shower curtains, synthetic-rubber bath mats . . . also in the manufacture of aspirin and antiseptics.

...for the Giant Consumer Market

The world is your market, and high polymer chemistry opens the door to new processes for the creation of new products to satisfy the hunger of this giant market.

Republic is vitally interested in this exciting new field of science. As an integrated steel maker, we are also a leading producer of high quality coal chemicals. Many of the basic chemicals used in making giant molecules come from the recuperative process of transforming coal to coke for our blast furnaces.

Republic Benzols, Toluols, Tar, Pyridine, Crude Naphthalene, Xylols, and Crude-Heavy Solvent are currently being used in the manufacture of thousands of products. Sulphate of Ammonia, in mixed and blended fertilizers, forms an industry in itself. Yet the surface has only been scratched. Of the nearly 2000 chemicals available from coal, only a small percentage have found their way into commercial use.

Concurrent with the work of polymer chemists in developing processes to speed the creation of new products and reduce the cost of present ones, Republic's own chemists are actively engaged in a program of coal chemical research. This program will enable Republic to keep pace in the rapidly growing field of giant molecules and to continue as a dependable source of supply for high quality, high purity coal chemicals.

Which of the Republic Coal Chemicals described at right and below can you use in your product or process to satisfy the giant consumer market?

THE GIANT CONSUMER MARKET reveals countless applications of Republic Coal Chemicals. Benzol is used in dyes for coloring cloth and fabric, in many types of wearing apparel, like nylon stockings, in synthetics for super-tough suitcases. It is also used in soaps and detergents. Perfumes are derived from Toluols. Pharmaceuticals are made from Pyridine. Xylols are basic in making riboflavin. Crude Heavy Solvents are used in waterproofing compounds and for stiffening leather.

COAL CHEMICALS ON THE FARM. Strong, healthy cattle reach marketable size faster. Xylols produced by Republic are used in the manufacture of germicides to protect livestock from germs and microorganisms. Ruined and farmed-out land is restored with the help of Sulphate of Ammonia in mixed and blended fertilizers. Benzol is a basic material in the production of agricultural chemicals designed to control pests, weeds, and plant diseases.

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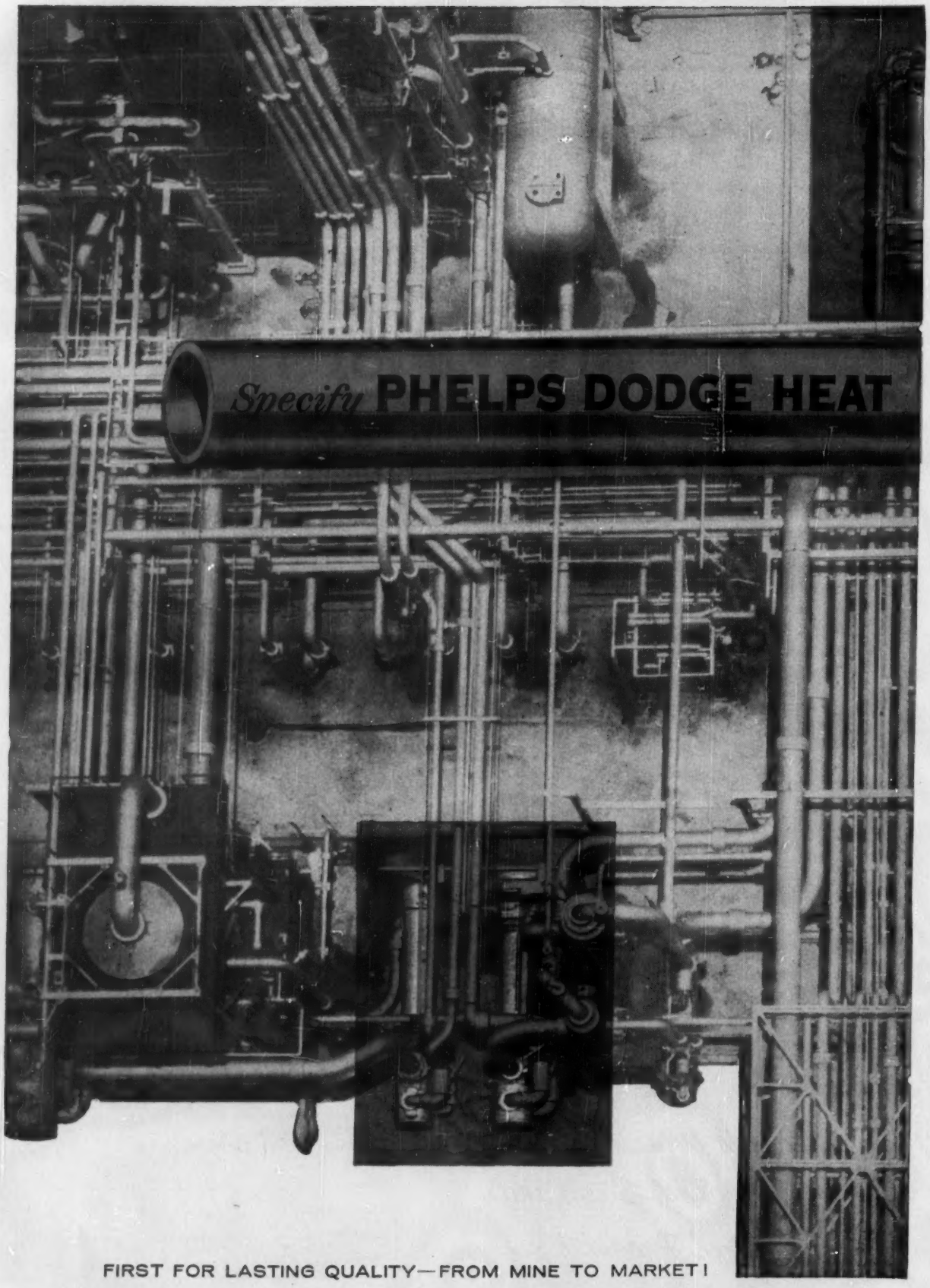
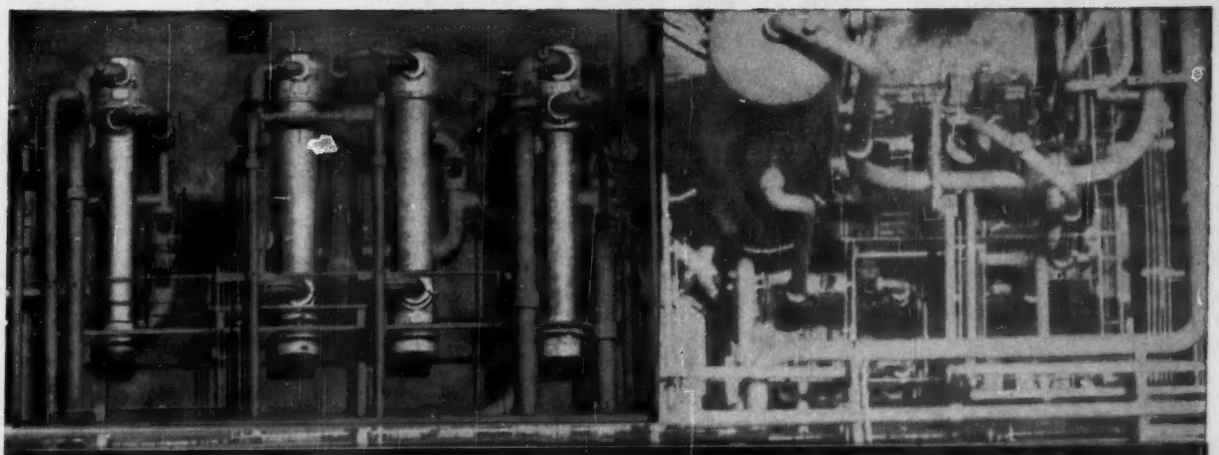


FIRST FOR LASTING QUALITY—FROM MINE TO MARKET!



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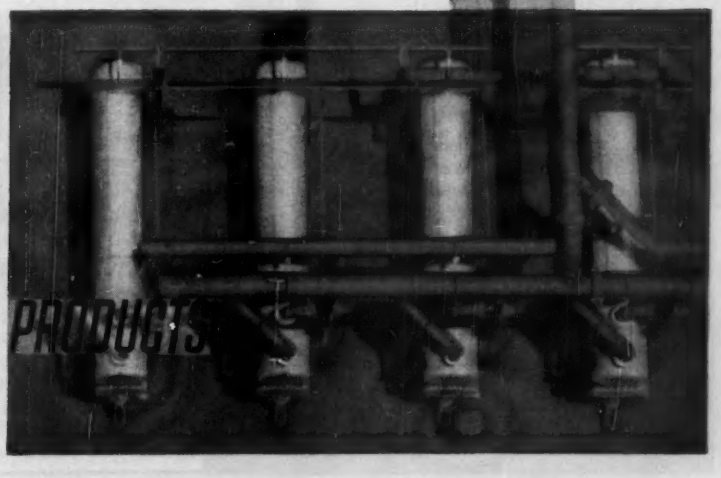
- Full range of copper-base alloys for every application.
- Vast background of application engineering to assist in proper alloy selection.
- Complete control of quality throughout every step of manufacture.



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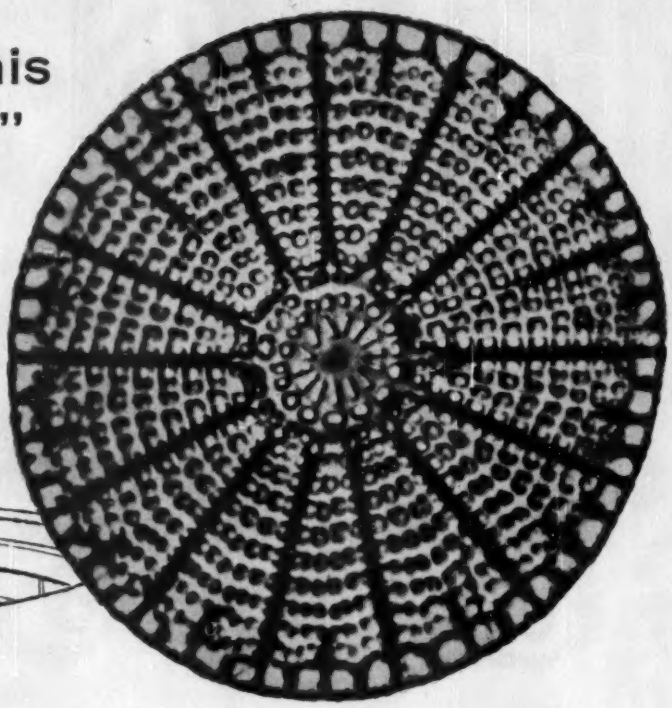
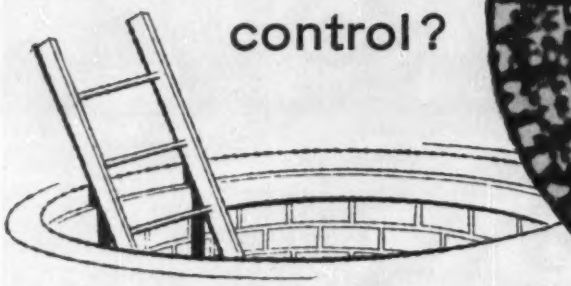
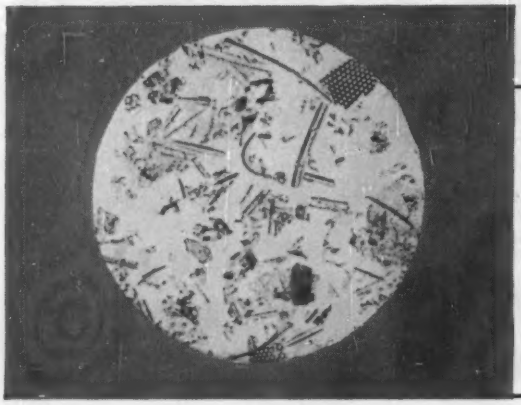
THIS "MANHOLE COVER" is really a magnification of *Arachnoidiscus ornatus*, one of the hundreds of different intricate particles that make Celite such an effective filter aid.

What's this "manhole cover" got to do with more accurate filtration control?





It's a particle of CELITE with the



The photomicrograph at left shows the wide variety of particle shapes and sizes in a typical Celite sample. By carefully controlling the proportions of particle sizes, the most complete range of grades is obtained.

Johns-Manville CELITE

Celite's wide range of grades permits precise control of several different filtration operations in the brewing of beer and ale. These include various ruh beer filtrations, wort filtration, final beer polishing and purification of brewing and bottle wash waters.

In industry's modern research laboratories, Celite filtration has proved itself an indispensable tool. Special grades of Celite have been developed that are particularly effective in analytical methods requiring filtration or chromotographic study.

In the manufacture of lubricating oils, Celite filter aids completely remove bleaching clay from the oil itself and also clarify the many additives used by the industry.

-the diatomite filter aid widest range of grades

Need maximum clarification? Use Celite* Filter-Cel. Or does your filtration require the fastest flow rates? Then use Celite 545. In addition, there are 7 more intermediate grades plus many special grades produced for specific applications. Thus, with Celite, you can establish the exact balance of clarity and flow rate that your process requires. No other diatomite gives you such a wide choice of grades.

Celite also gives you other important advantages over competitive filter aids. Its lower wet density provides greater surface coverage per pound. This means substantial savings because six bags of Celite actually do the work of seven bags of other diatomites.

And Celite is uniform. Every pound of Celite comes from the world's largest and purest commercially available diatomite deposit. Every pound is processed and graded at the same plant under the same conditions. Yet, with the large inventory maintained at the plant and Johns-Manville's nationwide network of warehouses, you're assured of fast, sure delivery.

So, if filtration belongs in your processing operations, it will pay you to call in your local J-M Celite engineer. Backed by Johns-Manville's research facilities and years of practical diatomite experience, he can help you with your filtration problems. Call him today or write Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

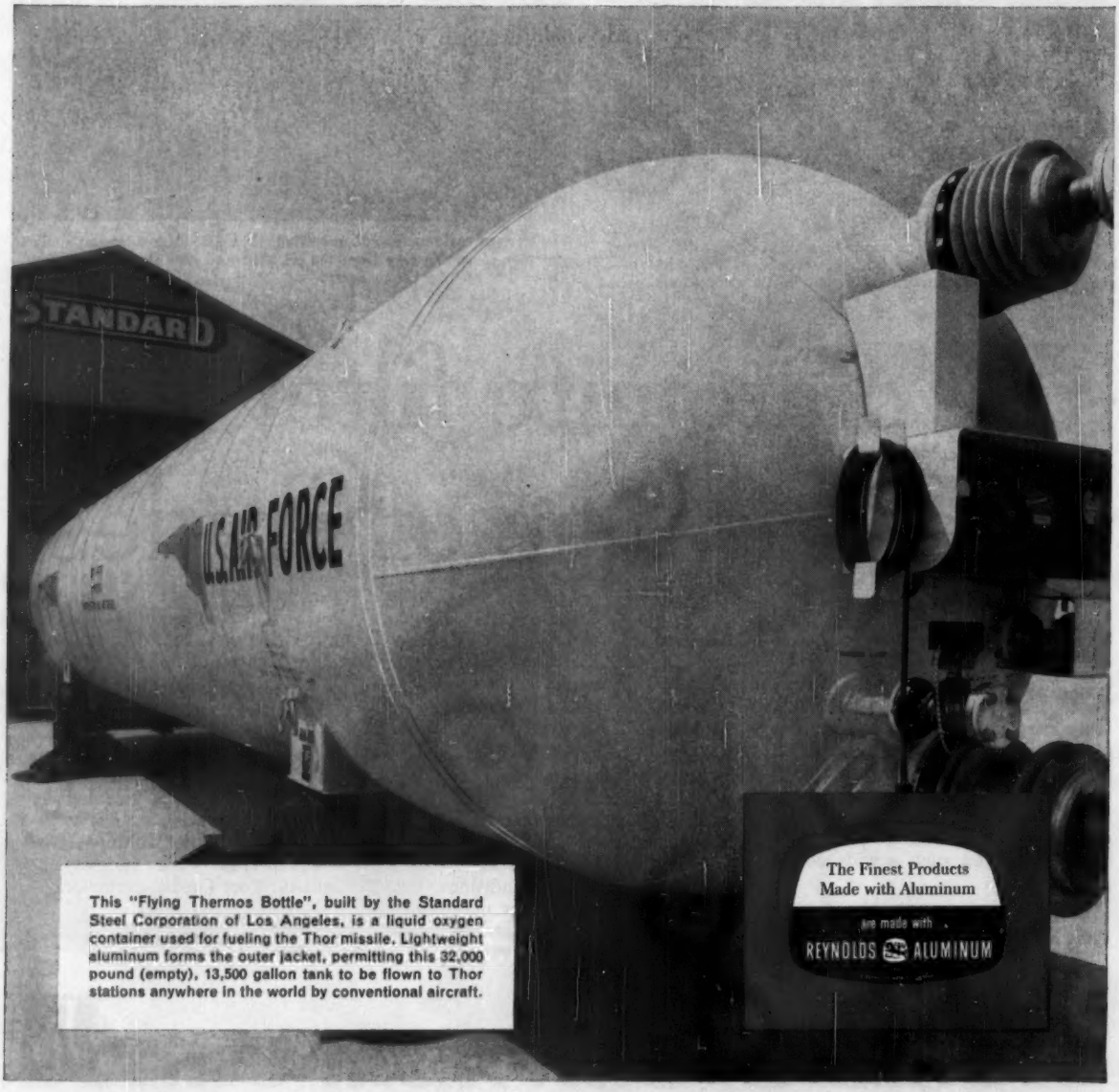
*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products.

Diatomite Filter Aids

JM PRODUCTS

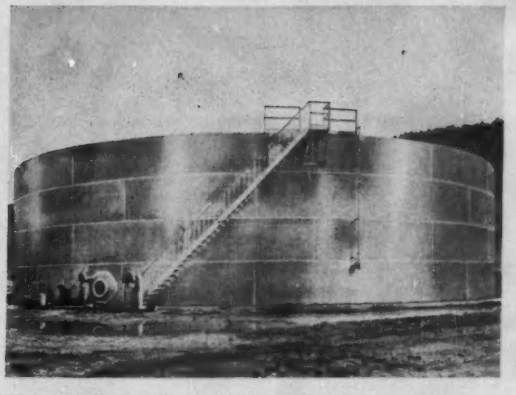
Aluminum Tanks and Vessels cost far less

...than those made with other corrosion-resistant metals!

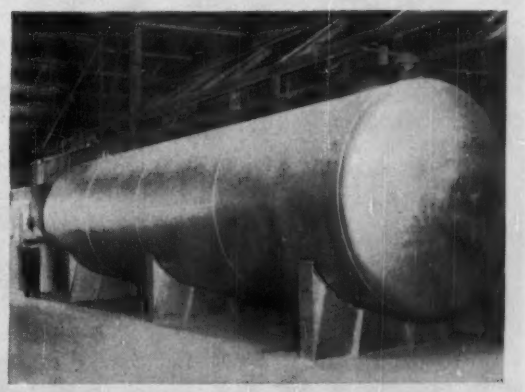


This "Flying Thermos Bottle", built by the Standard Steel Corporation of Los Angeles, is a liquid oxygen container used for fueling the Thor missile. Lightweight aluminum forms the outer jacket, permitting this 32,000 pound (empty), 13,500 gallon tank to be flown to Thor stations anywhere in the world by conventional aircraft.

The major costs of tanks or vessels are for initial materials and subsequent maintenance—and aluminum is the one corrosion-resistant alloy that offers big savings in both. It will not rust. It is corrosion-resistant in most atmospheres. And, it's easy to keep clean. Yes, aluminum costs less, far less, and here are more reasons why:



This giant aluminum tank holds ammonium nitrate solution. Non-sparking aluminum gives extra-long service under constant exposure to corrosion, with a minimum of maintenance.



Highly corrosive nitrogen solutions are safely stored in this tank made of Reynolds Aluminum for quick, local service to farmers for use in soil treatment.

CORROSION-RESISTANT

Aluminum resists corrosion from most process liquids. *Hydrogen peroxide, petroleum products, acetic acids, nitric acids, nitrogen solutions, turpentines, lacquers, beverages, sulphur-bearing gases*—all, and many other corrosives, can be handled in aluminum tanks and vessels without contamination or corrosion. Climatic conditions and atmospheric gases normally do not affect aluminum. Flammables may be safely stored in aluminum tanks and vessels, for aluminum is non-sparking.

LIGHTWEIGHT

Aluminum weighs just one third as much as steel. This means *one* man can often do the fabricating work of three. This is an important cost reduction, from the initial purchase through handling, shipping and fabrication, to final installation.

EASY TO FABRICATE

Tanks and vessels require high quality welding . . . and aluminum is an exceptionally easy-to-weld material. In fact, welds of comparable strengths can be made five to eight times faster on aluminum than on most other metals! Brazing equally well, it is also one of the most formable, most economical metals to work with.

EXCELLENT THERMAL CHARACTERISTICS

Reflecting up to 95% of radiant heat, aluminum provides superior protection for volatile chemicals. And aluminum's high thermal conductivity speeds the transfer of heat.

LOW TEMPERATURE PROPERTIES

Aluminum, due to its excellent mechanical properties and low cost, is the ideal material for handling low temperature liquids such as *liquefied oxygen, nitrogen, methane,* etc.

IN USE EVERYWHERE

Aluminum is finding wider and wider use in the processing industry because no other metal offers so many benefits at such large savings. To learn how Reynolds Aluminum can help you, or for technical service, call your local Reynolds office or write *Reynolds Metals Company, Box 2346-CJ, Richmond 18, Virginia.*

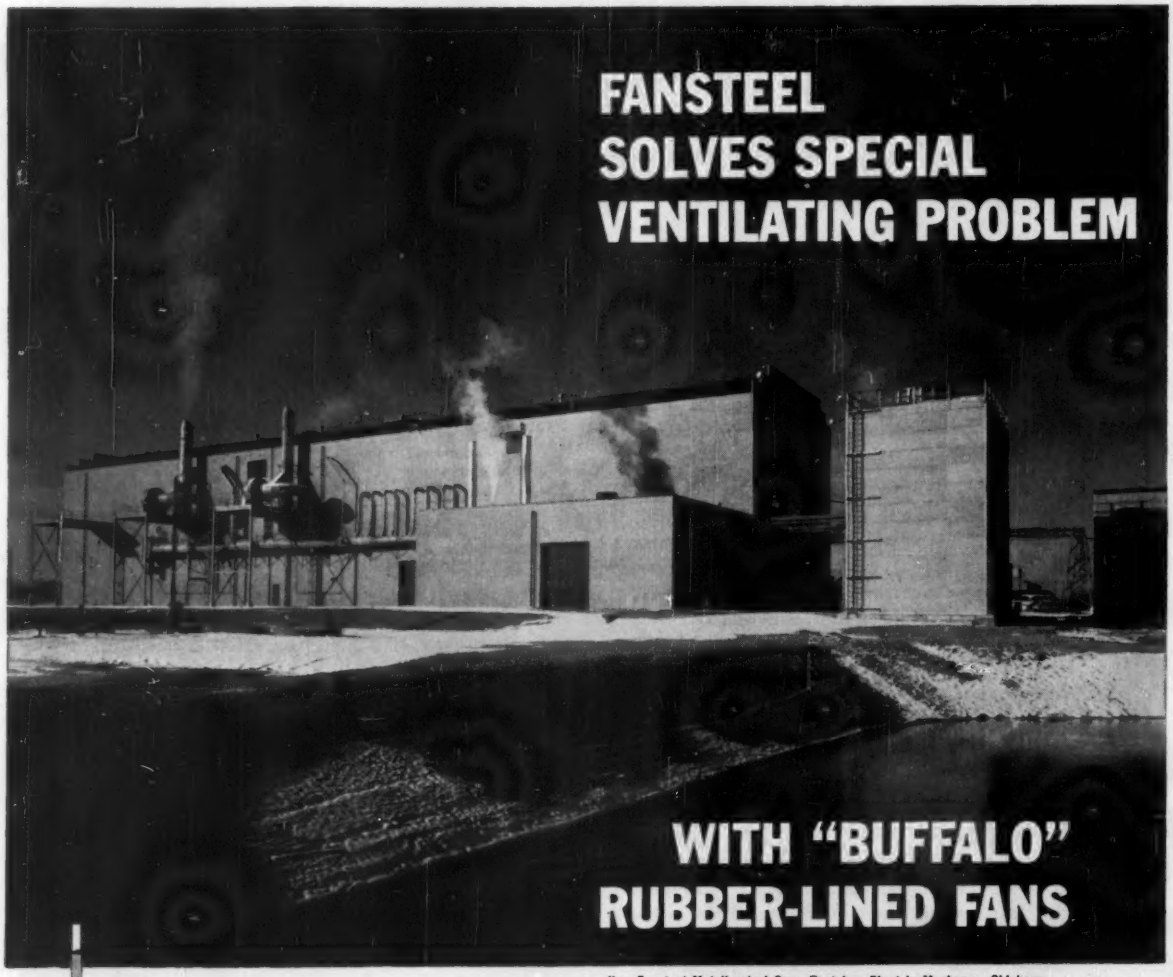
Write today for Reynolds Free Brochure on Aluminum Tanks and Vessels

REYNOLDS ALUMINUM

RICHMOND 18, VIRGINIA

Watch Reynolds new TV shows—**"WALT DISNEY PRESENTS"** and **"ALL-STAR GOLF"**—every week on **ABC-TV.**

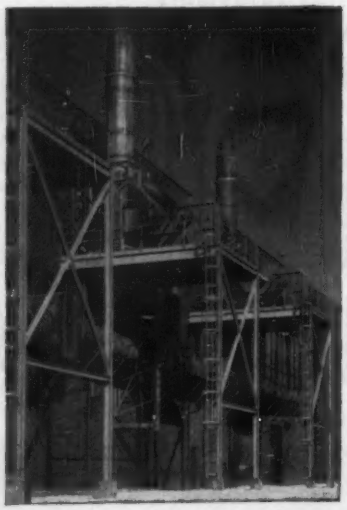
FANSTEEL SOLVES SPECIAL VENTILATING PROBLEM



WITH "BUFFALO" RUBBER-LINED FANS

New Fansteel Metallurgical Corp. Tantalum Plant in Muskogee, Oklahoma

Tantalum Capacitors like this are made from Fansteel Tantalum. They are important components of electronic, aircraft and missile systems.



"Buffalo" Rubber-Lined Fans provide efficient ventilation for the critical control necessary in the Chemical Operations Building of Fansteel's new, ultra-modern tantalum plant.

Key point in Fansteel's new facilities is the Chemical Operations Building, where the valuable metals tantalum and columbium are produced. Removing impurities and extracting the metals from the ores requires a series of precisely-controlled chemical and electrochemical operations.

Where air handling is so important, it is understandable that Fansteel should turn to "Buffalo", whose 81 years of engineering experience assures satisfactory ventilation under critical conditions.

"Buffalo" Rubber-Lined Fans are noted for their ability to withstand many years of punishing service. Rubber is vulcanized to all parts of the fan exposed to the air stream. There is no possibility of separation, hardening or cracking. Savings in down-time and fan parts more than pays for the slight extra cost of the rubber.

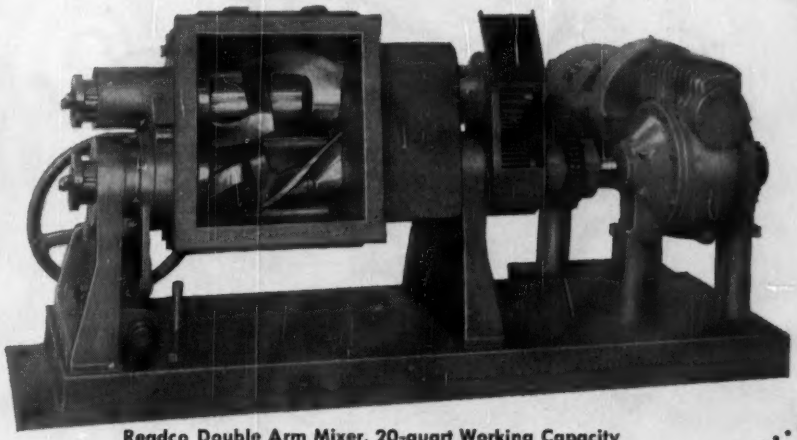
Whatever the type of severe service *your* fans may encounter, there is probably a "Buffalo" Fan to handle the job. Contact your nearby "Buffalo" engineering representative, or write direct for Bulletin 2424-F today.

BUFFALO FORGE COMPANY
BUFFALO, NEW YORK

"Buffalo"

Buffalo Pumps Division, Buffalo, N. Y.
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

VENTILATING • AIR CLEANING • AIR TEMPERING • INDUCED DRAFT
EXHAUSTING • FORCED DRAFT • COOLING • HEATING • PRESSURE BLOWING



Readco Double Arm Mixer, 20-quart Working Capacity

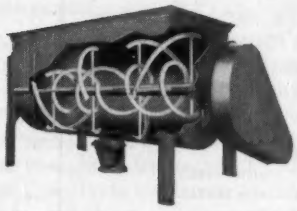
Predict production precisely with READCO Lab and Pilot Plant Mixers

Incorporating all the basic design features of larger production models, Readco Laboratory and Pilot Plant mixers enable you to make accurate forecasts for commercial processing.

Mixing bowls are accurately machined and fitted . . . have vacuum covers and temperature controlling jackets. Overlapping sigma mixing arms are held in constant close clearance, eliminate dead spots, prevent build-up of materials, aid temperature control. Easily interchangeable mixing arms adapt to various materials or processes.

Ruggedly built of Type 316 stainless steel, or any commercial alloy, Readco lab and pilot plant mixers will efficiently handle even heavy viscous material. They are available from stock in 1, 3, 6, 20 and 40-quart working capacities, with fixed or variable speed drives. For more information see Chemical Engineering Catalog, pages 1567-15740 . . . or write direct.

READCO



Readco Spiral Ribbon Mixers—Batch or Continuous. Standard sizes 1 to 500 cu. ft. working capacities.

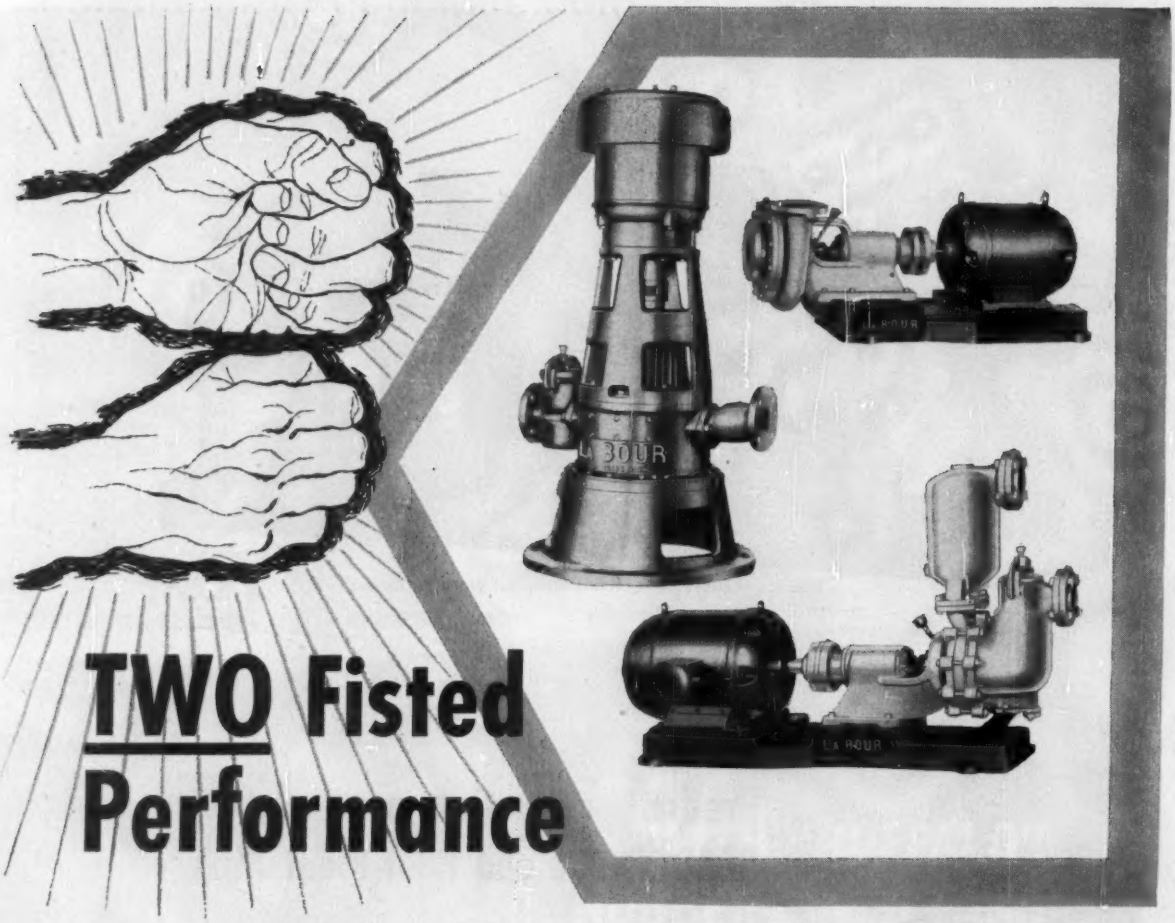
Readco Vertical Mixers, planetary action, multiple speed, 12 to 175 qt. working capacities. (Model K-20 illustrated)

Whatever the mixing job . . . a READCO mixer!

READ STANDARD

York, Pennsylvania

A Division of Capitol Products Corporation



In pumping chemicals, maximum service satisfaction is dependent on *two* factors. Design and construction quality constitute one factor; the other is the accuracy of the foundry in meeting metallurgical specifications for corrosion resistance.

Because LaBour pumps embody such important and exclusive features of design it is perhaps easy to overlook the fact that LaBour foundries employ equipment and techniques second to none for precise control of alloy composition and grain structure.

That's why, when you buy LaBour, you get *two*-fisted performance assurance. Top ability to resist corrosion *and* top ability to move liquids economically and dependably are combined in these pumps. Ask for Bulletin B-1b.

REGULAR PRODUCTION IN LaBOUR FOUNDRIES INCLUDES THESE ALLOYS:

- Electric Furnace Cast Iron
- Bronze
- Lead
- Aluminum
- R-55 (Chrome-Nickel)
- Y-17 (Chrome-Nickel-Molybdenum)
- Y-30 (Nickel-Molybdenum)
- 149 Stainless Steel
- 304 Stainless Steel
- 316 Stainless Steel
- Elcomet K (High Nickel Stainless)

ORIGINAL MANUFACTURERS OF THE SELF PRIMING CENTRIFUGAL PUMP

LaBOUR

THE LaBOUR COMPANY, INC. • ELKHART, INDIANA, U. S. A.

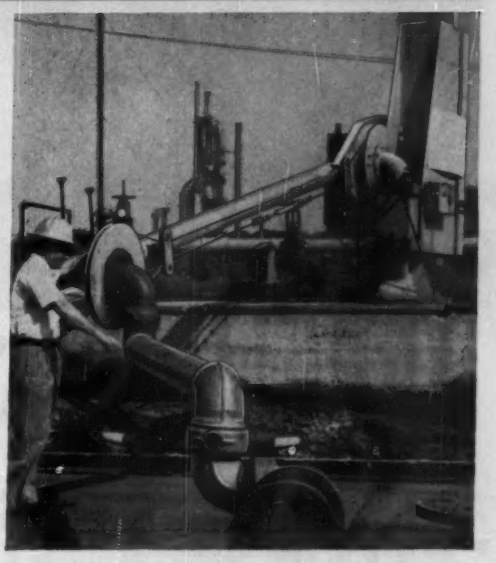
CHIKSAN

PREVENTS LINE HANDLING INJURIES
SPEEDS BARGE LOADING
ELIMINATES HOSE BURSTS
SLASHES REPLACEMENT COSTS

The Chiksan Barge Loading Arm ends hazardous manhandling of loading hoses, eliminates dangerous dock clutter. Mechanical operation makes hookup fast and simple.

Gear reduction enables one man to adjust the flange position anywhere in a 105° vertical range. Outboard arm is manually swung into position at any point in a 130° horizontal arc. The eight inch model rotates 360° to permit servicing barges on both sides of a narrow dock. Once hookup is made, the arm can be left unattended while free wheeling allows the unit to ride free during loading and unloading. When not in use, the arm is raised up and out of dockside traffic.

6″ x 25′ and 8″ x 28′ sizes available. Handle petroleum products, both black and bright, and mild caustics in any temperature ranging between —60° F. to +225° F. Service all river and lake barges and lake tankers including those in 25,000 barrel class.



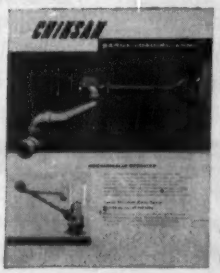
The Chiksan Barge Loading Arm is designed to reach approximately 20 feet from dock riser to barge flange. Total length of Arm is 25 feet.

fmc **CHIKSAN**

A SUBSIDIARY OF
FOOD MACHINERY AND CHEMICAL CORPORATION

CHIKSAN COMPANY — BREA, CALIFORNIA
CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas
Subsidiaries: Chiksan Export Company
Chiksan of Canada, Ltd.



CHIKSAN COMPANY
330 No. Pomona Ave., Brea, Calif.

Please send me your Barge Loading Arm Bulletin #456.

Name_____
Title_____
Company_____
Address_____
City_____ Zone____ State_____

58-36

Experience**—the extra alloy in **Allegheny Stainless

key words in solving production puzzles:

Allegheny for Stainless; Ryerson for Service

If one of your toughest production puzzles is getting top quality stainless steel *when* you need it, check in now with the Allegheny-Ryerson combination.

Allegheny Ludlum is the leading producer of stainless steels in all forms. And Ryerson, long recognized as the largest and best steel service center, carries Allegheny Stainless. This unbeatable team brings you the best quality stainless quick, when you need it.

Ryerson now stocks 2,351 shapes, sizes, finishes and alloys of Allegheny Stainless . . . the most complete line of stainless anywhere! And Ryerson relieves you of the inventory cost, gives you as quick service as your own stockroom.

Whether your order is for Allegheny Stainless sheet, plates, bars or whatever, Ryerson stocks it. Trained salesmen and technicians to help in selecting or in fabricating are at your service.

Call Ryerson, for top quality Allegheny Stainless from warehouse stocks. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.***

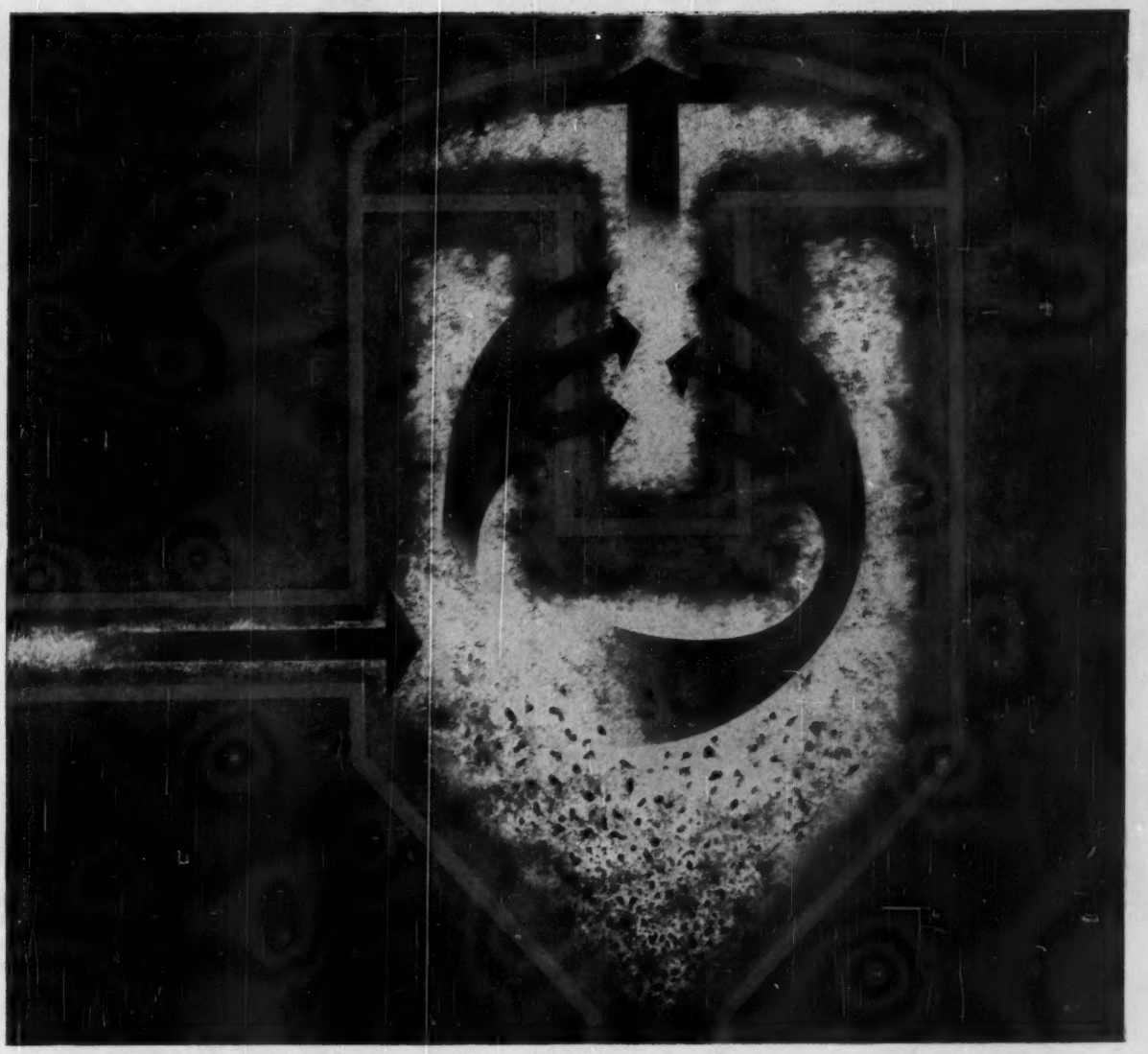
WSW 7124

ALLEGHENY LUDLUM

for warehouse delivery of Allegheny Stainless, call RYERSON

Export distribution: AIRCO INTERNATIONAL

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT



Filters for extreme conditions

HIGH HEAT *plus* CORROSION

Processing Uranium Hexafluoride by gaseous diffusion.

Operating at a temperature so high (over 1200°F) that the filter and its housing are red hot, this specially designed and constructed Purolator frameless metal edge filter reclaims fines from the highly corrosive gas.

The extreme heat and the corrosive gas are necessary for the process . . . Purolator's problem was to come up with the filter which could do the job required under these conditions. The filter, constructed of monel, combines a porous metal facing on a frameless metal edge element. It has been in constant operation since its installation.

Difficult jobs like this are made to order for Purolator. Designing and producing filtration equipment to meet exacting demands requires the combination of engineering skill and manufacturing know-how only Purolator offers.

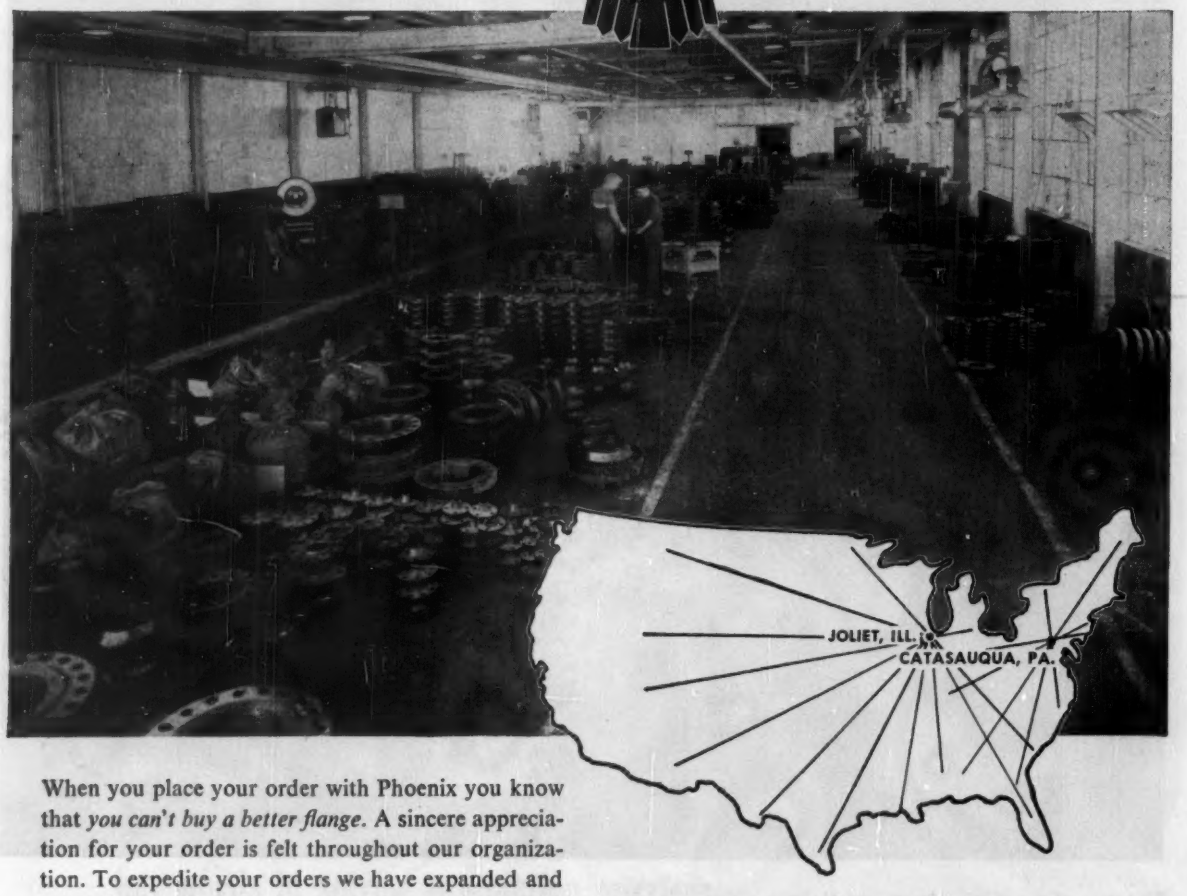
Two brochures outline what Purolator can do for you on your toughest filtration requirements. They're both yours for the asking. Write to Jules Kovacs, Vice President in charge of Technical Sales. If you have an urgent filtration problem *now*, send Mr. Kovacs the details of it.

Filtration For Every Known Fluid **PUROLATOR**

PRODUCTS, INC.

RAHWAY, NEW JERSEY AND TORONTO, ONTARIO, CANADA

Why Service On PHOENIX FLANGES Is So Good!



When you place your order with Phoenix you know that *you can't buy a better flange.* A sincere appreciation for your order is felt throughout our organization. To expedite your orders we have expanded and streamlined our warehouse facilities, as shown, to make Phoenix service even better. For your regular requirements or special flanges in carbon or alloy steel, contact Phoenix and we'll show you what we mean.

Write for handy 36 page pocket-size reference booklet containing useful data on flanges.

IMMEDIATE SHIPMENT FROM TWO FACTORY WAREHOUSES

Conveniently located in the East near Philadelphia and Metropolitan New York and in the Midwest near Chicago, Phoenix factory warehouses at Catasauqua, Pa. and Joliet, Ill. are prepared to ship immediately regular types and sizes of quality Phoenix forged steel pipe flanges. That's why prompt delivery is assured—overnight to nearby points —in only a few days to distant points.

Leading Manufacturers of Pipe and Tank Flanges and Commercial Forgings

PHOENIX

FLANGE AND FORGING DIVISION

PHOENIX MANUFACTURING COMPANY

DIVISION—UNION TANK CAR COMPANY

CATASAUQUA, PA. • JOLIET, ILL. • FOUNDED 1882

PHOENIX DIVISIONS: FLANGE AND FORGING DIVISION, STEEL MILL DIVISION, HORSESHOE PRODUCTS DIVISION, FABRICATING REBAR DIVISION

A large diameter steel head takes form on one of Claymont's spinning machines—units that turn out heads up to 19 feet in diameter, in ferrous and non-ferrous metals. Integrated facilities make Claymont a reliable source of quality steel plate and plate products for industry

by d'Arazien

CLAYMONT SPUN HEADS

CF&I

CHECK CLAYMONT FOR—Alloy Steel Plates • Carbon Steel Plates • Stainless-Clad Steel Plates High Strength Low Alloy Steel Plates • CF&I Lectro-Clad Nickel Plated Steel Plates • Pressed and Spun Steel Heads • Manhole Fittings and Covers • Fabricated Steel Products Large Diameter Welded Steel Pipe

PRODUCTS OF WICKWIRE SPENCER STEEL DIVISION • THE COLORADO FUEL AND IRON CORPORATION

Plant at Claymont, Delaware • Sales Offices in all Key Cities

5745

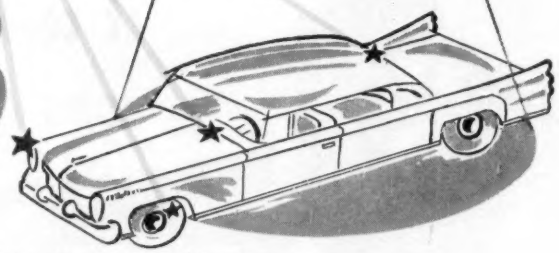
SULPHUR ONE OF THE FOUR STRONG PILLARS OF PROCESSING

INVISIBLE

BUT PRESENT

35 POUNDS OF SULPHUR

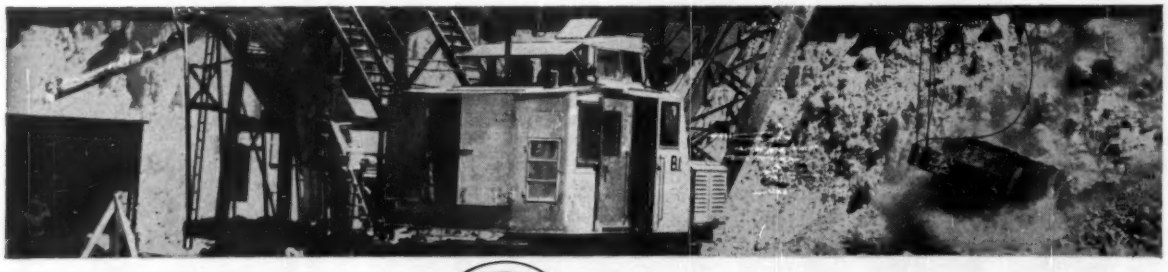
and derivatives help to produce the average automobile



Sulphur enters the automobile picture in two ways: directly and indirectly.

Sulphur, either as the elemental or as one or more derivatives, is used in the manufacture of rubber and rayon. Indirectly, it is used in processing the steel that forms the body. It is used in the plating operation on trim and fixtures. It is deliberately introduced into certain steels to provide better machining qualities.

Recognizing the importance of Sulphur to the basic industries such as the manufacture of automobiles, and to our ever-expanding economy generally, TGS is broadening its service: production, distribution and technical.

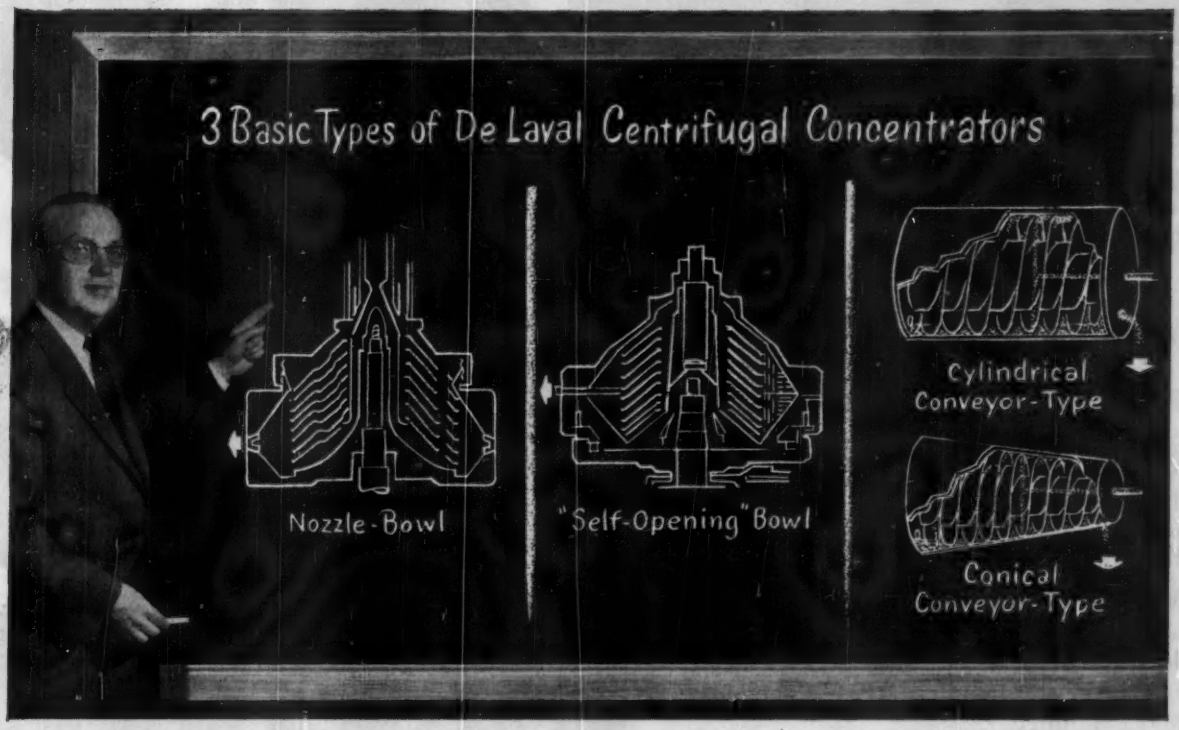


SULPHUR PRODUCING UNITS

• Newgulf, Texas • Spindletop, Texas
• Moss Bluff, Texas • Worland, Wyoming
• Fannett, Texas

TEXAS GULF SULPHUR CO.

75 East 45th Street, New York 17, N. Y.
811 Rusk Avenue, Houston 2, Texas



"These 3 types of centrifugal concentrators give you continuous concentration of solids,"

Fred Wheelwright, De Laval Separator Co.

The fast, continuous way to recover or concentrate a solid product from a slurry is by centrifugal force. Compared to slow, cumbersome batch-settlers, De Laval centrifugal concentrators give you high speed and continuous-flow processing. Furthermore, centrifugals take up only a fraction of the floor space required by settling tanks.

De Laval manufactures all three basic types of continuous centrifugal concentrators. So it's not painful for us to be completely objective when we're called on to recommend a particular machine for a given set of process data. Briefly, here's a general description of the three types:

Nozzle-bowl: As in all centrifuges, our nozzle-bowl centrifugals throw the solids to the outside, against the bowl. But instead of being held there, the solids are concentrated and discharged continuously through the specially designed nozzles built into the bowl wall. (See sketch)

The nozzle-bowl will handle any product in which the concentrated solids can be pumped. For extra-high concentration, the concentrate can be recirculated through the bowl. The nozzle-bowl successfully produces some concentrations as high as 40% by volume.

"Self-opening" bowl: This is something of a misnomer, because the "solids discharge aperture" (see sketch) is kept closed by hydraulic pressure until solids in the bowl are built up to a predetermined amount. Hydraulic pressure on the bowl is then relieved by automatic controls or manually, thus opening the bowl (while it is running at full speed) and ejecting the solids.

We apply this machine on liquids containing fibrous-type solids, where a high concentration is needed (up to 50% by volume). As opposed to the nozzle-bowl, this machine gives high concentration on products which break down or foam when recirculated.

Conveyor-type: There are really two types here . . . cylindrical and conical (see sketches). Both are used for concentration of crystalline-type solids. The conveyor screw rotates slower than the bowl but in the same direction. As the solids build up on the bowl, the conveyor carries them to the discharge ports.

The conical-type is best for solids which pack tightly and have a high angle of repose. The cylindrical-type is best for soft, plastic solids.

Experience generally enables us to dictate the type of machine best suited for a given application. But it is still a fact that you can't always predict how a material will behave when it's subjected to centrifugal force. This keeps us humble, and it also keeps our pilot plant busy. In our lab and pilot plant, we can simulate most process conditions and determine the most efficient way to get concentration.

If you'd care to send us the design criteria or process data on your concentration problems, we will give it careful analysis and submit objective recommendations. All in strictest confidence, of course. Or for literature on any of the machines I've described, just write on your letterhead (but say which type of machine you're interested in).

DE LAVAL
SEPARATOR COMPANY

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York
5724 N. Pulaski, Chicago 46, Illinois

DE LAVAL PACIFIC COMPANY
201 E. Millbrae Avenue, Millbrae, Calif.

35 to 25,000 GPM/LP*

In the rapidly expanding chemical field, essential water supply for operations and transfer is met by Layne Vertical Turbine Pumps.

Whether the supply or the demand calls for a 4 inch well or any size up to 42 inches, Layne Pumps are designed and engineered to deliver the required GPM economically and unfailingly.

Pioneers and acknowledged leaders in the field of water, Layne produces pumps designed to meet multiple service requirements efficiently and economically.

*/LP—Per Layne Pump

LAYNE & BOWLER, INC., **MEMPHIS**
GENERAL OFFICES AND FACTORY • MEMPHIS 8, TENN.
LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD

Layne

WATER WELLS • VERTICAL TURBINE PUMPS
WATER TREATMENT

To: Layne & Bowler, Inc.
Memphis 8, Tennessee

Gentlemen: Please send me bulletin No. 100.

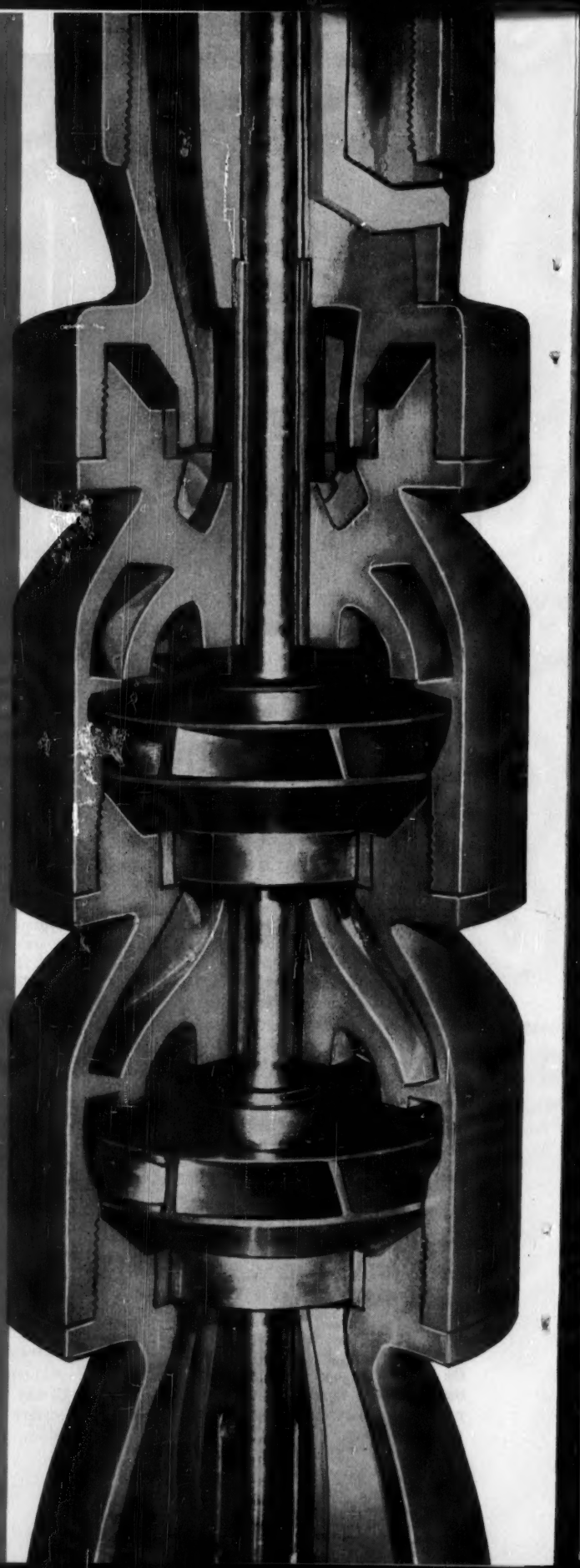
*Name*_____

*Title*_____

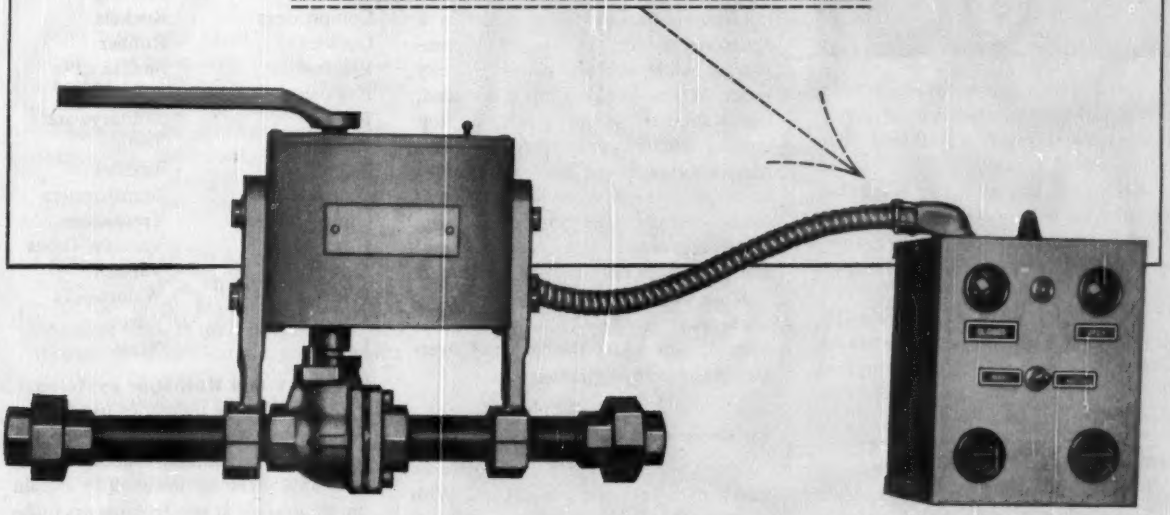
*Organization*_____

*Address*_____

*City*_____ *State*_____



Now operate ROCKWOOD remote ball valves with a flip of a switch



Rockwood now offers an electric control that opens or closes ball valves *instantly* — from any distance away!

This new remote control can be operated on AC or DC current. It can be operated automatically by thermostat, float switch, or several other means (or by hand in case of power failure). It can be used with any one Rockwood Ball Valve up to 2", or with an entire row of them. The particular unit shown above has been test run a million cycles at 300 P.S.I. without a single failure.

The Rockwood electric control makes all hand controls for hard-to-get-at ball valves obsolete. And of course it mounts around dependable Rockwood Ball Valves, the only ball valves you can be sure will give you full, round flow, long wear-resistance, and leak-proof seal at all times. Call, wire, write for more facts today from Rockwood Sprinkler Company. Rockwood Ball Valves are tested and listed by Underwriters' Laboratories, Inc. Distributors in all principal industrial areas.

ROCKWOOD BALL VALVES

ROCKWOOD SPRINKLER COMPANY
1066 Harlow Street
Worcester 5, Massachusetts

Please send me your new Rockwood Full-Flow Ball Valves Catalog No. 57.

Name.....
Title.....
Company.....
City.....
Zone.....*State*.....

Kathabar® systems control all air dimensions... temperature, humidity and purity

You will earn maximum profits from an investment in comfort air conditioning if you specify a Kathabar "full-dimensional" system.

All over the country, Kathabar systems have improved labor productivity in hot and soggy weather, reduced absenteeism, and brightened employee morale.

These profits alone have justified the Kathabar equipment, but there are additional benefits which distinguish Kathabar air conditioning from conventional systems:

extra returns

The Kathabar system automatically conditions *all three* vital dimensions of air—temperature, humidity, and purity. Its control of humidity is a feature favored by users, because it eliminates the shock you feel when you enter or leave spaces conditioned by conventional refrigeration.

The system will either dehumidify or humidify.

specify bacteria count

Air purity is important for both comfort and health, and a Kathabar system contributes to each. Its chemical wash removes odors and dirt from the air. Even better, it kills over 97% of airborne micro-organisms. This drastically reduces the exposure of people and products to mischievous bacteria and molds.

With a Kathabar system, you can actually specify the maximum bacteria count you will tolerate in your space!

Dehumidification for comfort in a Kathabar system is usually accomplished with cooling tower or city water. Where refrigeration is included, the Kathabar system gives you top cooling efficiency with surprising savings in tonnage and horsepower. This is because the system handles latent loads with chemical absorption using lower cost water, and frees refrigeration to handle only the sensible loads.

Since dehumidification is direct (by a chemical absorbent) in a Kathabar system, you avoid the costs of overcooling and re-heating.

no carry-over

The absorbent will not vaporize or carry over into the air stream. With routine checking, it will maintain its effectiveness for years without replacement. The germicidal and bactericidal results are not affected by absorbent age or condition, or whether the system is humidifying or dehumidifying.

Be sure to check the Kathabar system if you want the greatest returns on your air conditioning investment.

who uses Kathabar systems

Kathabar systems make profits out of air for these industries:

Atomic Energy	Machining
Breweries	Matches
Cake Mix	Marine
Candy	Meat
Cellophane	Offices
Cellulose	Ordnance
Cereals	Paper
Chemicals	Pharmaceuticals
Coffee	Plastics
Comfort	Printing
Compressors	Rockets
Cookies	Rubber
Electronics	Shellac
Explosives	Sugar
Film	Sanitaryware
Foundries	Testing
Gelatin	Textiles
Glass	Transformers
Glue	Transistors
Gum	Vacuum Tubes
Hospitals	Varnish
Hotels	Waterworks
Lacquer	Wire
Lenses	Yeast

how they use Kathabar systems

Many of these industries use Kathabar systems for comfort. Others use them to (1) maintain spaces at 80 F and 55% RH or lower; (2) obtain continuous air at sub-freezing dry bulbs and dew points; (3) eliminate condensation; (4) improve drying processes; (5) maintain spaces at specific low bacteria or mold count.

send description of your problem

AIR CONDITIONING & DRYING DIVISION
SURFACE COMBUSTION CORPORATION
2380 Dorr Street Toledo 1, Ohio

Kathabar systems by Surface

JENKINS

O.S.&Y. U-BOLT GATE

MADE BETTER THAN NEED BE . . .

Costs Less to Use

YOU PAY NO MORE for the extra quality you see in every part of a Jenkins Outside Screw & Yoke U-Bolt Gate valve. Yet longer life and reduced maintenance is bound to result from the extra ruggedness, the precision manufacture and unique design features which Jenkins puts into these popular, general utility valves.

Choose the Outside Screw & Yoke pattern for services where spindle threads must be kept out of the destructive effects of fluids in the line; where spindle threads must be cleaned and lubricated regularly or where a rising spindle is needed to indicate wedge position.

Choose JENKINS, whether O.S. & Y. or Inside Screw pattern, for valves built to save maintenance dollars.

WIDE RANGE OF JENKINS U-BOLT GATES

GET FOLDER NO. 207 which describes Inside Screw and O.S. & Y. patterns . . . Iron Body with Bronze or Stainless Steel Mounting . . . All-Iron and Ni-Resist with type 316 Stainless Steel trim. Ask your local Jenkins Distributor or write Jenkins Bros., 100 Park Avenue, New York 17.

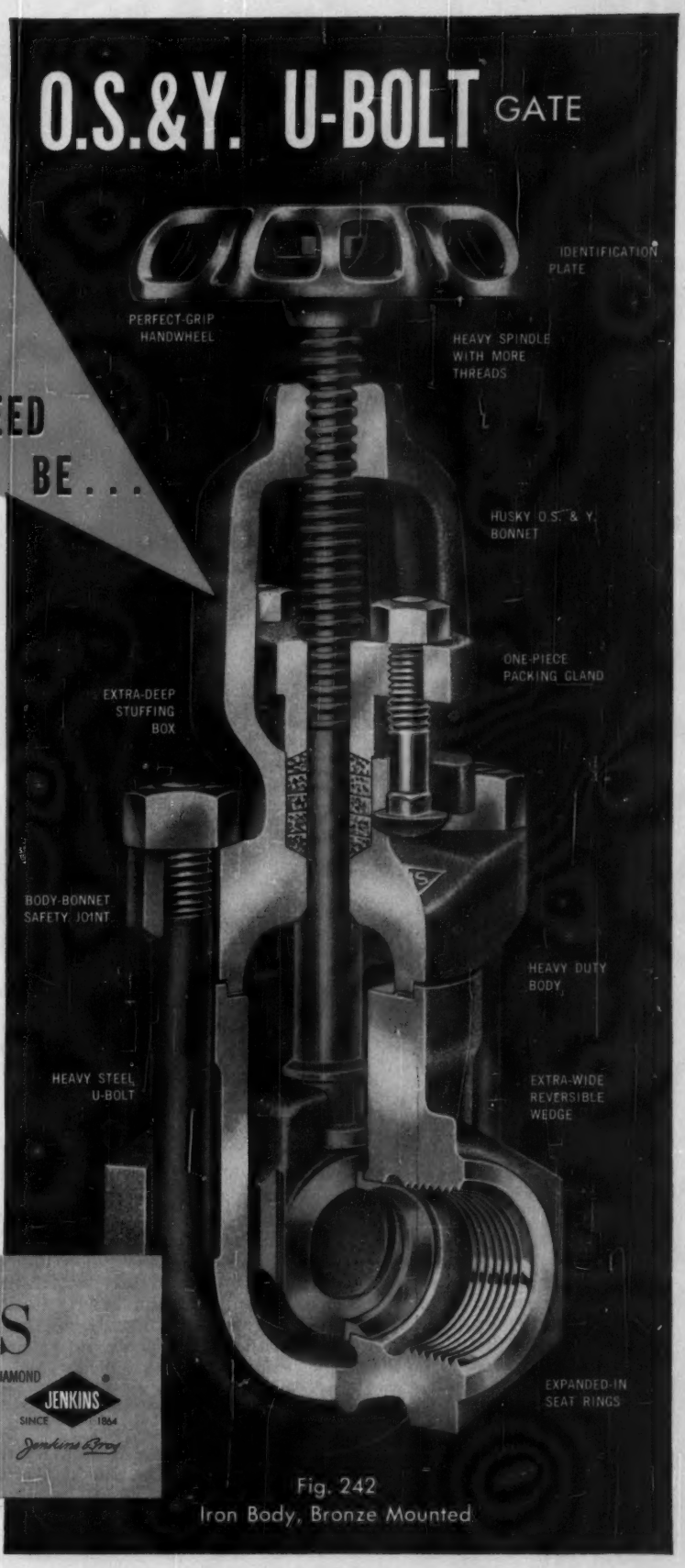


Fig. 242
Iron Body, Bronze Mounted

JENKINS VALVES

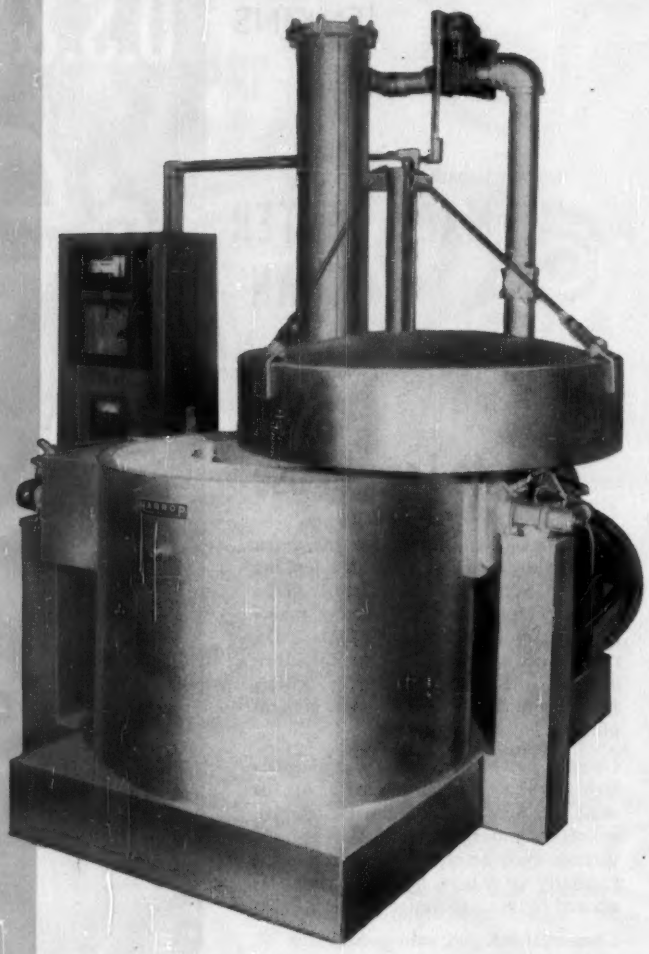
LOOK FOR THE JENKINS DIAMOND

JENKINS SINCE 1864 Jenkins Bros.

Sold Through Leading Distributors Everywhere

New Protection For YOUR Equipment— At Temperatures Up To 3300°F

ALUNDUM castables offer unusual advantages to all industries using high temperature installations*



Will fire continuously up to 3300°F. This Harrop gas-fired furnace, recently developed by the Electric Furnace Division of the Harrop Ceramic Service Company, Columbus, Ohio, is particularly applicable to the firing of ceramic oxide bodies. Norton ALUNDUM 33-I Insulating Castable selected for the inner lining of the furnace and its roof, provided completely satisfactory protection under repeated tests at highest operating temperatures.

The new Norton ALUNDUM Castables are made in two types: 33-I Insulating and 33-HD Heavy Duty. At temperatures up to 3300°F both types have been extremely successful in protecting high temperature processing — in many industries and many different installations.

ALUNDUM 33-I Insulating Castable is made up primarily of pure aluminum oxide bubbles, tiny and countless. Forming a network of air spaces, it assures excellent insulation, even at highest commercial temperatures.

ALUNDUM 33-HD Heavy Duty Castable is chiefly composed of dense grains of pure aluminum oxide. It is recommended for forming dense monolithic surfaces in many types of furnaces where high temperature conditions are particularly severe.

Both 33-I and 33-HD Castables are very easy to store, mix and use. With them you can cast simple or complex shapes quickly and economically, replace more expensive pre-fired shapes, and cut maintenance and replacement costs to very lowest. Ask your Norton Representative for details, and for the folder *Two Norton Castables.* Or write to NORTON COMPANY, Refractories Division, 513 New Bond Street, Worcester 6, Massachusetts.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON
REFRACTORIES
Engineered... Rx ...Prescribed

Making better products . . . to make your products better

NORTON PRODUCTS Abrasives • Grinding Wheels • Grinding Machines • Refractories • Electrochemicals — BEHR-MANNING DIVISION Coated Abrasives • Sharpening Stones • Pressure-Sensitive Tapes

NEW! FULLY STANDARDIZED EXCHANGER OFFERS UNPRECEDENTED FLEXIBILITY

down go costs and delivery time for the process industries

It's here . . . the most versatile heat exchanger ever developed for the chemical industry — the Ross C-100. Of quality construction throughout, it is pre-engineered and fully standardized, by-passing high costs and delays inherent in custom fabrication.

Readily assembled to handle any combination of liquids and gases, the C-100 can be used as a heater, cooler, condenser or vaporizer for hundreds of process applications.

Extreme flexibility predominates . . . in materials, sizes and arrangement of components, mounting position, tubeside passes, nozzle orientation. Your choice is virtually limitless in meeting a tremendous range of conditions.

Want specific details? New illustrated Bulletin 302.5K1 will bring you all the facts on design, materials, sizes and adaptability. Send the coupon for your copy.

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Please send your new illustrated Bulletin 302.5K1 fully describing the Ross Type C-100 Heat Exchanger.

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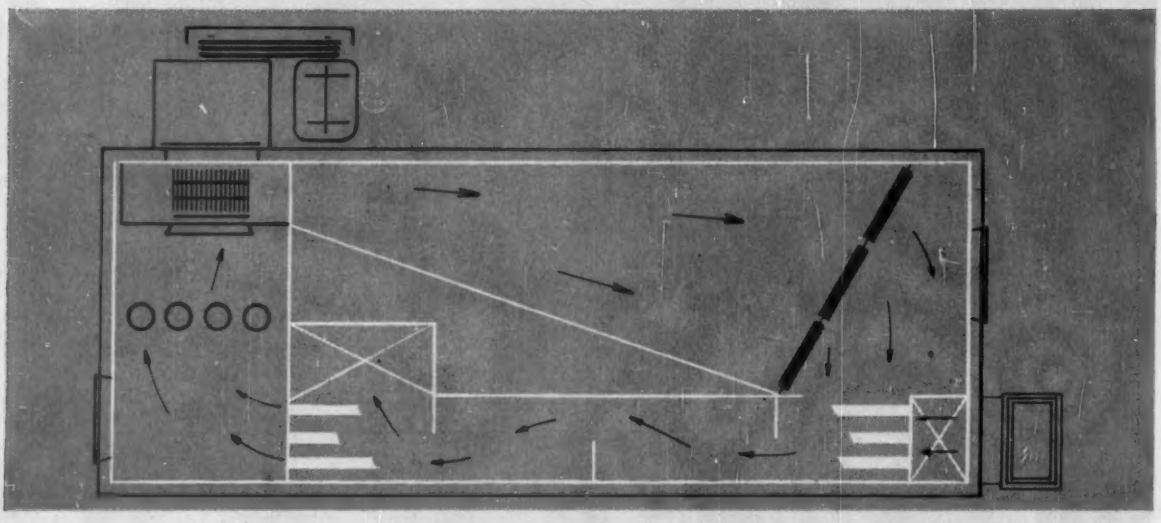
New steels are born at Armco

Armco ALUMINIZED STEEL Resists Heat and Corrosion

In Catalytic Combustion Fume Elimination



A catalytic combustion unit that oxidizes fumes to odor-free, color-free gases. All interior lining of the housing, interior baffles, distributors, ductwork and heat exchanger tubing are made of Armco ALUMINIZED STEEL.

Disposal of objectionable contaminants in waste gases by catalytic combustion has eliminated serious community relations problems for many chemical processing plants. And a special Armco hot-dip aluminum coated steel provides the combination of heat- and corrosion-resistance to give these fume control units economical durability.

A leading producer of this type of chemical plant equipment reports:

> **"Armco ALUMINIZED STEEL exhibits good corrosion resistance in handling air, superheated steam and vaporized organics and hydrocarbons at elevated temperatures—above condensation temperatures.**
>
> **"Its heat resistance is equal to that of expensive alloys at service temperatures up to at least 1200 F.**
>
> **"There has never been any spalling of the protective coating due to fluctuating temperatures or flexing of the metal."**

Armco ALUMINIZED STEEL, combining the surface characteristics of aluminum with the strength and rigidity of steel, is being used for a wide variety of chemical processing equipment. Applications include carbon black burner shields, stack shields, reactor covers, insulating pipe cover, radiant heat reflectors and many other parts.

See how you can improve the efficiency and durability of the equipment *you* make or use with the unique advantages of Armco ALUMINIZED STEEL Type 1. Write us today for complete information. Armco Steel Corporation, 7088 Curtis Street, Middletown, Ohio.

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

Already a Great Success!
The Amazing New AO R-90
"RED DEVIL"
Respirator Filter

The "Red Devil" is a real advance — brought about by research to provide you with the finest protection against dusts and mists. A variable density filter with built-in prefilter. Long service life — low breathing resistance — extremely high filtering efficiency are features. Outperforms previous filters yet is available to you at no extra cost. An American Optical Company exclusive — insist on it. "Red Devil" filters are available in the AO Respirators shown below.

The R-5090 "Red Devil" Respirator
Bureau of Mines APPROVED for protection against dusts not significantly more toxic than lead, pneumoconiosis-producing mists and chromic acid mist. A double cartridge respirator — has two variable density filters and two built-in prefilters. R-90 "Red Devil" Filters for the R-5090 Respirator are available in package of 10 or package of 100.

The R-2090 "Red Devil" Respirator
Bureau of Mines APPROVED for protection against dusts not significantly more toxic than lead, pneumoconiosis-producing mists and chromic acid mist. R-90 "Red Devil" Filters for the R-2090 Respirator are available in package of 5 or package of 50.

Made only by American Optical Company, world's leading manufacturer of personal safety equipment. Your nearest AO Safety Products Representative can supply you or write for literature.

Always insist on ® Trademarked Safety Products

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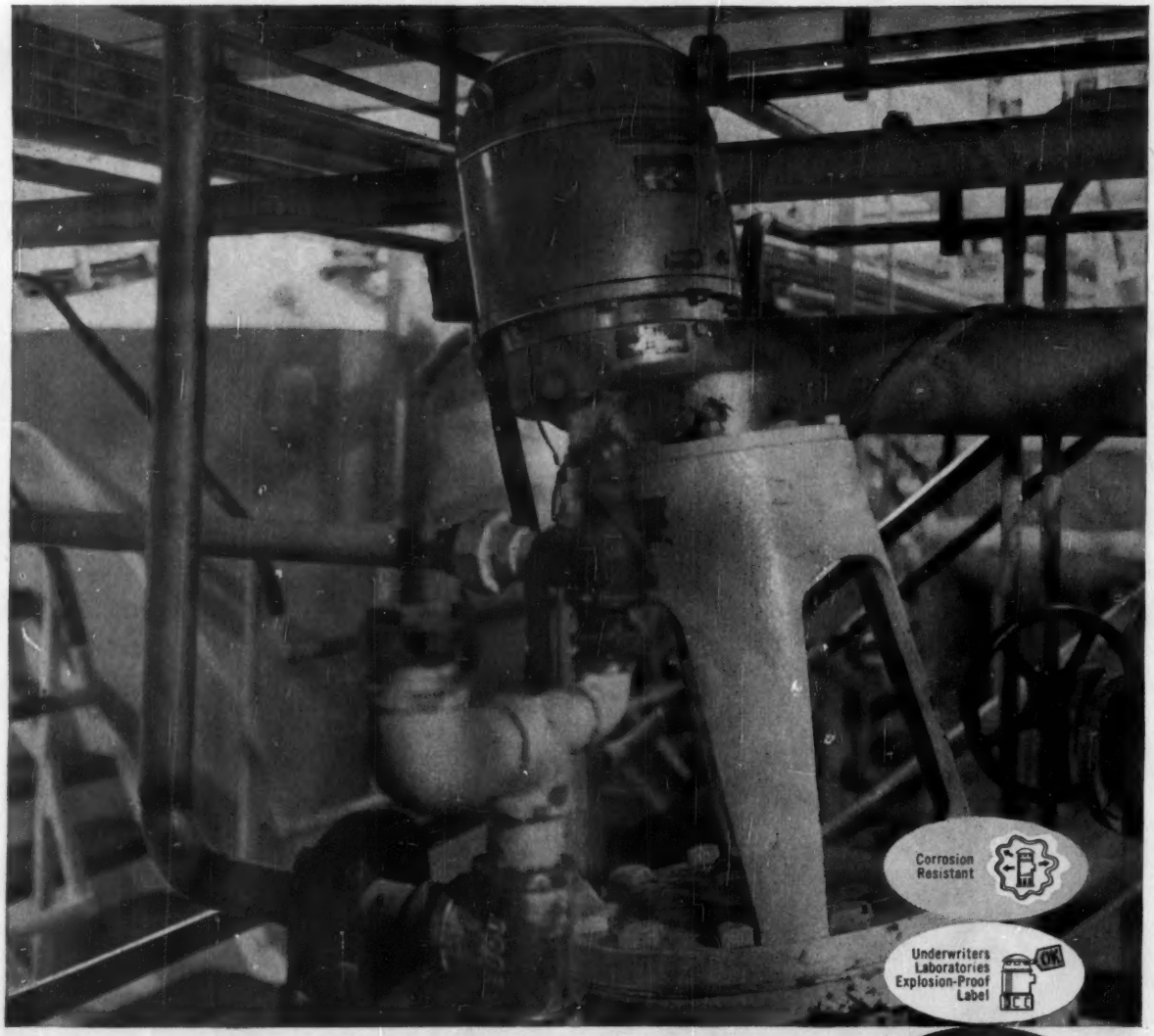
SAFETY PRODUCTS DIVISION

SOUTHBRIDGE, MASSACHUSETTS
Safety Service Centers in Principal Cities

1833-1958 — 125 LEADERSHIP YEARS



This motor battles corrosion

Louis Allis explosion-proof chemical motors are ideal for chemical, petrochemical, plastics, and paint installations.

It takes a motor designed for the chemical industry to withstand the abuse of this corrosive service. The 2 hp totally-enclosed fan-cooled explosion-proof motor shown above on a mixer drive is typical.

Few applications are subjected to such extreme environmental conditions. To meet them, Louis Allis chemical motors are built with cast-iron housings to provide exceptional corrosion resistance to etching vapors and corrosive gases. Motor shrouds are stainless steel, fans are bronze. Even the nameplate is made of stainless steel to preserve important motor information like bearing sizes and the wiring diagram for simplified servicing.

Louis Allis insulation is designed to withstand exposure to acids, alkali, or moisture to assure you of dependable service. Locked bearing construction prevents rotor drift . . . extends bearing life.

We'll gladly offer expert field application service. Contact your Louis Allis District Office or write The Louis Allis Company, 447 East Stewart Street, Milwaukee 1, Wisconsin. Ask for Bulletin 1050.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

Standard or special, simple or complex—

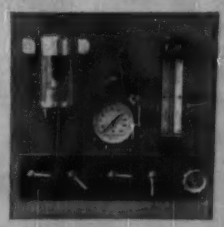
M-S-A Sample Systems and Accessories help produce unerring answers to your gas analysis problems

Proper handling of a sample stream can make a critical difference to the analytical instrument user. It may well be *the* determining factor in achieving positive results.

That's why the subject of proper sample handling has received so much emphasis at MSA. Already, we have spent thousands of engineering manhours on design, development, and testing of sampling systems and sample system components. Specifically, for use with M-S-A Infra Red, Thermatron, Oxygen, Combustible Gas, Water Vapor, and Carbon Monoxide Analyzers.

A great majority of the analyzers that we build have been supplied as part of a complete system, including all necessary sampling accessories. Because of the variety of sample conditions, a single system will not satisfy all requirements. Many MSA systems have been successfully applied so many times, however, that they have become standard. In other cases, we have developed special combinations of these standard units to handle problems peculiar to a certain application. Or, we have supplied individual components to a user where the application has not required an elaborate system.

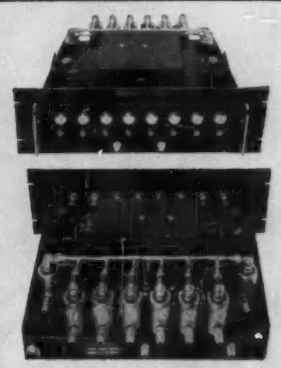
An MSA Instrument Specialist can help you pinpoint the results you can expect from MSA Analyzers equipped with any or all of these versatile units. Our new bulletin, *M-S-A Sample Systems and Accessories for Gas Analysis* lists applications, features and advantages for the complete line. Write for your copy.



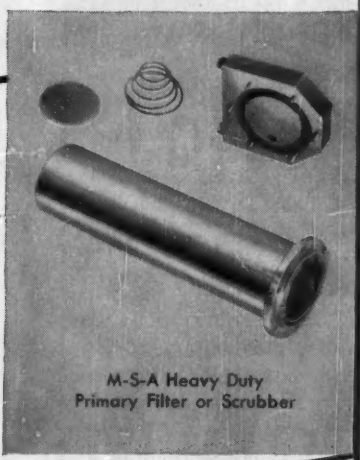
M-S-A Standard Systems

INSTRUMENT DIVISION
Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

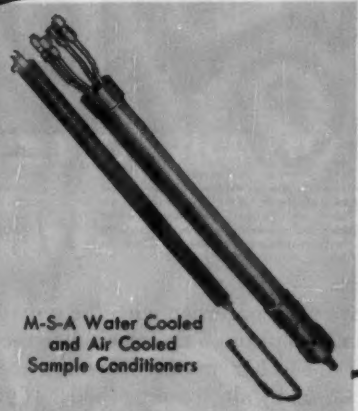
M-S-A Combination Filter and Liquid Separator



M-S-A Station Selector *Multipoint*

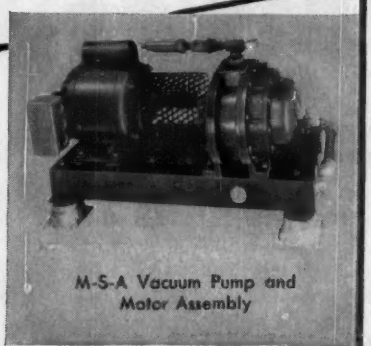


M-S-A Heavy Duty Primary Filter or Scrubber



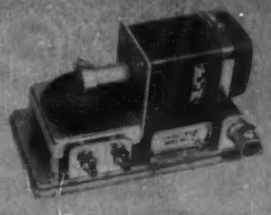
M-S-A Water Cooled and Air Cooled Sample Conditioners

M-S-A Low Pressure Regulator



M-S-A Vacuum Pump and Motor Assembly

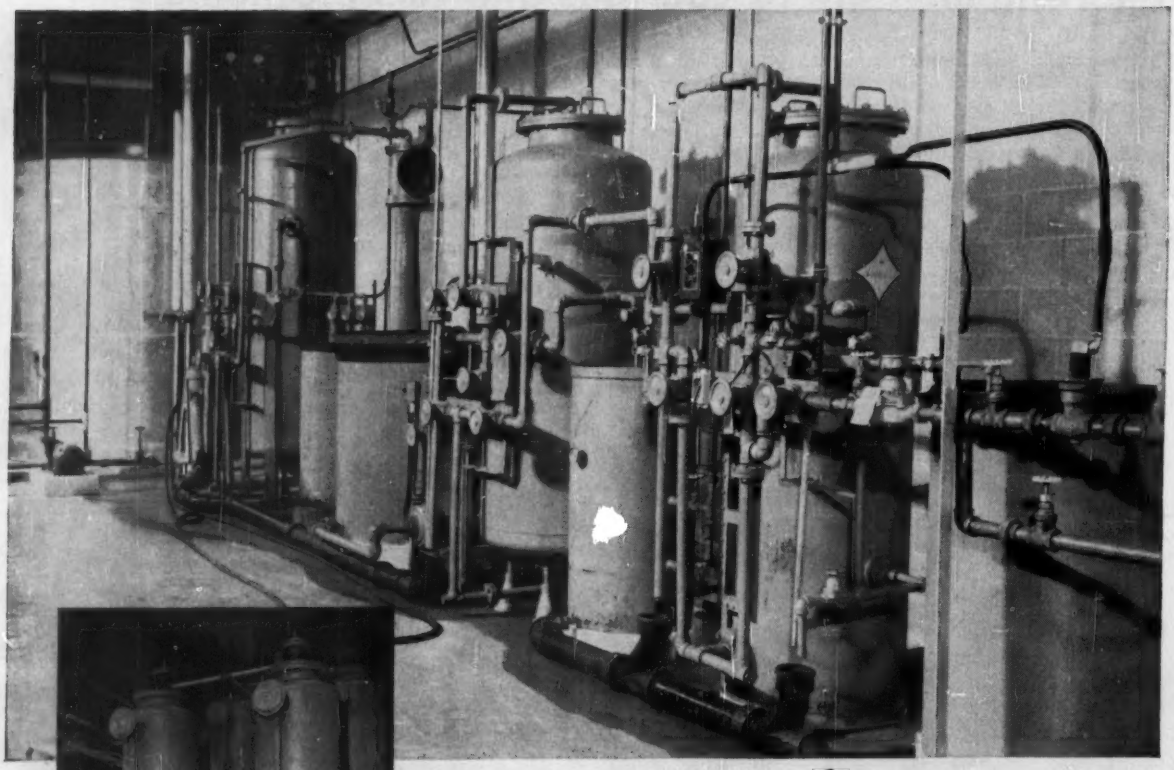
M-S-A High Efficiency Small Volume Filter

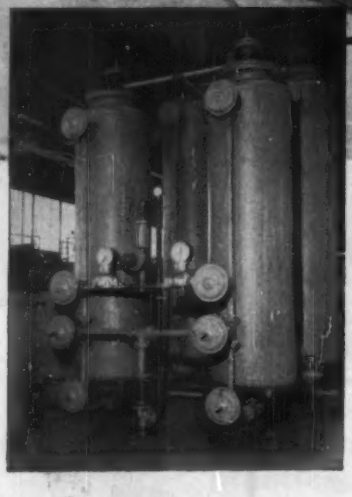


M-S-A Diaphragm Pump and Motor Assembly

INDUSTRIAL ION EXCHANGE TECHNIQUES

. . . low cost solution to specialized purification problems





EXAMPLE 1: *Purification of Formaldehyde.* Specialized anion exchange technique removes formic acid from formaldehyde. This *Industrial* semi-automatic, dual unit also "up-grades" water white formaldehyde for resin manufacture—yields final resins with resistance to off-color blush or bloom.

EXAMPLE 2: *Chemical preparation.* An *Industrial* mixed-bed ion exchange unit used for removal of sodium formate and formic acid from an organic polyhydric alcohol intermediate. Process facilitates subsequent purification by evaporation.

• Are you concerned with the removal of mineral impurities from solvent solutions—chemical intermediates—purification of glycerine—or other materials which usually require tedious, costly processing by alternate methods? If you are faced with the problem of purifying such materials, and if they contain even traces of moisture, then *Industrial*-engineered ion exchange techniques and equipment may provide a complete and inexpensive answer to your problem.

The two installations of *Industrial* ion exchange equipment illustrated here are typical of the many specialized applications of ion exchange developed and engineered by *Industrial* to meet specific chemical process industry requirements.

To evaluate the possibilities of these techniques to solve your purification problems, and to obtain an analytical study, consult *Industrial*, soon.

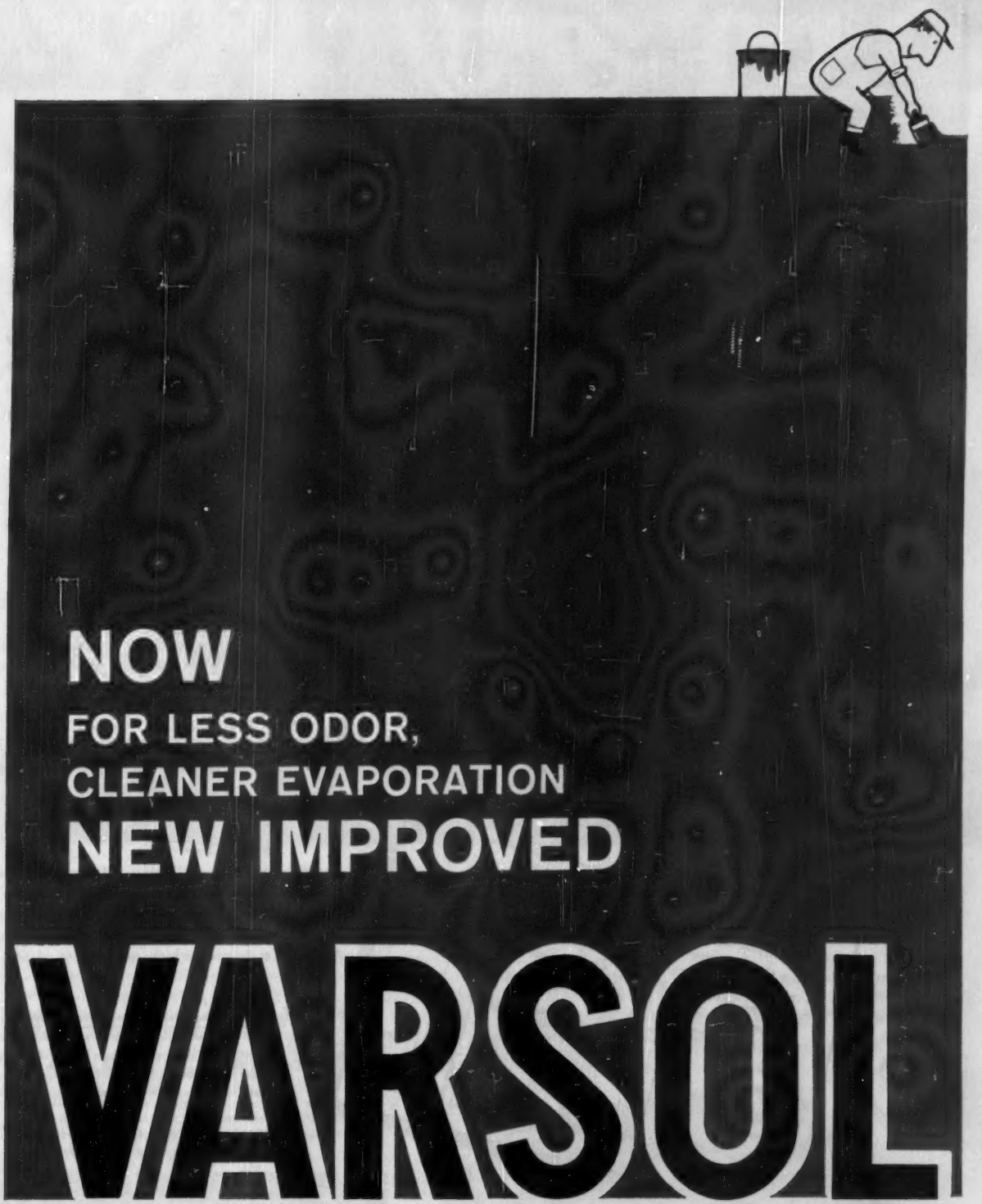
For general information covering *Industrial* Ion Exchange equipment, write for a copy of BULLETIN 200.

INDUSTRIAL

C-158

INDUSTRIAL FILTER & PUMP MFG. CO.
5918 Ogden Avenue, Chicago 50, Illinois

PRESSURE FILTERS ◆ ION & HEAT EXCHANGERS ◆ WASTE-TREATING EQUIPMENT



For the latest quality improvements in mineral spirits, you can count on *new* Varsol. This top-grade Esso solvent is specially tailored by *new* refining techniques and finished to *new* levels of odor and volatility. Here is a real change in your raw material availability picture: an old standby — Varsol — now better than ever! For technical assistance with your solvents problems, contact your nearest Esso Standard Oil Company office, or write Esso Standard Oil Company, Solvents Division, 15 West 51st Street, New York 19, New York.

ESSO RESEARCH
Works Wonders with Oil

Esso

A COMPLETE FAMILY OF AROMATIC SOLVENTS FOR ALL OF INDUSTRY'S REQUIREMENTS
SOLVESSO 100 • SOLVESSO 150 • SOLVESSO TOLUOL • SOLVESSO XYLOL
PETROLEUM SOLVENTS

WESTERN PRECIPITATION'S

NEW THERM-O-FLEX COLLECTOR

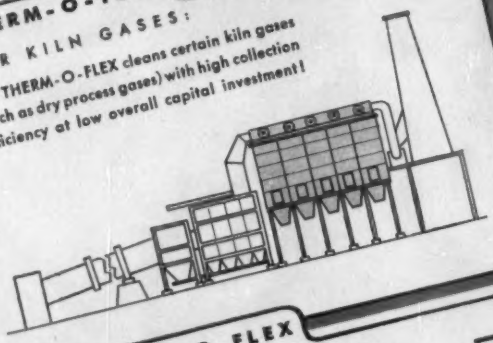
CLEANS GASES TO 550°F

with VIRTUALLY 100% COLLECTION!

THERM-O-FLEX

FOR KILN GASES:

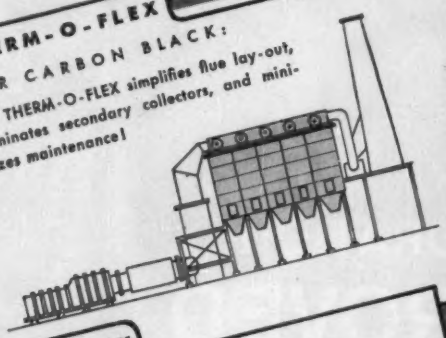
The THERM-O-FLEX cleans certain kiln gases (such as dry process gases) with high collection efficiency at low overall capital investment!



THERM-O-FLEX

FOR CARBON BLACK:

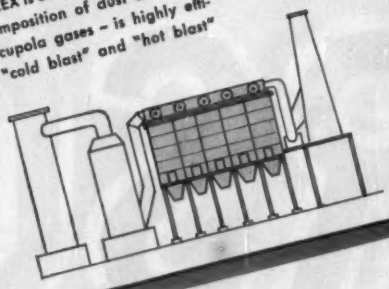
The THERM-O-FLEX simplifies flue lay-out, eliminates secondary collectors, and minimizes maintenance!



THERM-O-FLEX

FOR CUPOLA GASES:

The THERM-O-FLEX is unaffected by the varying chemical composition of dust and fume particles from cupola gases – is highly efficient on both "cold blast" and "hot blast" processes!



Western-Precipitation brings another important new advancement to the gas cleaning field — the THERM-O-FLEX Collector — a filter type of unit with many advantages over conventional filter equipment...

- The THERM-O-FLEX features glass silicone treated filter tubes that efficiently handle gases as hot as 550° F!
- The THERM-O-FLEX tubes are cleaned *automatically* by intermittent collapsing (not by destructive shaking). This assures uniformly low pressure drop combined with long filter life!
- The THERM-O-FLEX has *no moving parts* — nothing to require frequent servicing or replacement!

RESULT — highest collection efficiency combined with lower cost, less maintenance and uniformly low pressure drop on a wide range of applications, a few of which are shown at left.

Let Our Experienced Engineers study your dust or fume collection problem — *large or small* — and show exactly how **THERM-O-FLEX** gives new standards of performance at low installation costs. No obligation, of course!

THERM-O-FLEX literature will gladly be sent. Write or phone, the Western-Precipitation office nearest you.

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Jet-Cleaned Filters
THERM-O-FLEX Hi-Temp Filters
TURBULAIRE-DOYLE Scrubbers
HOLO-FLITE Processors
HI-TURBIANT Heaters

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Engineers and Constructors of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries

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Need COOLER RUNNING MOTORS for your big jobs?

In Ratings thru 500 hp Standard TEFC or Explosion-Proof

WAGNER Tube Ventilated Motors can solve your problem

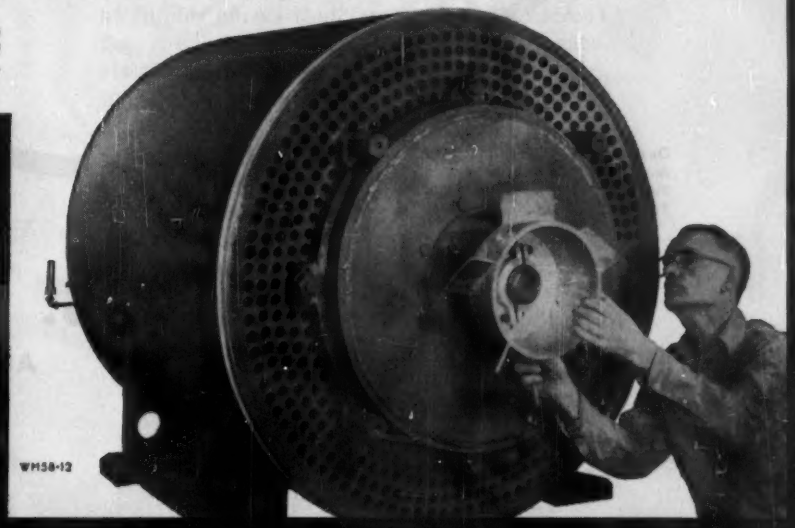
For big fans, blowers, pump drives—heavy duty applications where you need large motors with highly effective cooling systems for long life—choose Wagner Tube Ventilated Motors.

These motors have fabricated steel frames that are provided with a series of tubes through which cooling air is forced by an external blower. Internal blowers, one at each end of the rotor, circulate the warm air inside the motor through ducts in the rotor and stator and around the cooling tubes. This effective cooling system holds the operating temperature of the motor within the specified limits of 55° C Rise for Class A or 75° C for Class B insulated motors.

Wagner tube ventilated motors are available as Type YP, standard TEFC, with Class A or Class B insulation; or as Type ZP, explosion-proof, with Class A insulation only. Type ZP motors can be supplied with Underwriters' Labels for Class I, Group C or D, or for Class II, Group E, F or G locations. Let your Wagner Sales Engineer show you how these motors can solve your big motor problems.

WAGNER ELECTRIC CORPORATION • 6407 Plymouth Ave., St. Louis 14, Mo.

This 400 hp tube ventilated motor is being tested on a 1000 hp dynamometer at the Wagner plant. Photo of motor at right, with blower shield removed, shows cooling tubes and external blower.



WH58-12

How large can a Packed Column be ?

Up until a relatively few years ago packed columns in excess of 8 feet to 10 feet in diameter were generally restricted to specific operations such as gas drying or water cooling. In liquid-liquid extraction, in distillation, diameters of packed columns beyond 4 feet were considered impractical and uneconomical.

Today, due to the development of more efficient tower packings (such as Intalox Saddles and metal Pall Rings) and more effective methods of distribution, there is virtually no limit to the diameter of an efficient packed column.

We know of two towers 53 feet in diameter with packed beds 26 feet deep. Scrubbing towers 25 feet or more in diameter are becoming quite common. And in distillation operations where perforated trays or bubble caps had been almost universally specified for columns larger than 4 feet, packed columns 10 feet to 12 feet or more in diameter are being used with increasing frequency.

In operations involving Absorption, Stripping, Cooling, Fractionation, Distillation or Liquid-Liquid Extraction, the packed column offers greater efficiency at lower installation and operating costs in virtually any size.

333-F

Designers, Engineers and Manufacturers of Metal and Ceramic Towers, Tower Accessories, and Tower Packings.

U. S. STONEWARE

AKRON 9, OHIO

DEVELOPMENTS . . .

DECEMBER 15, 1958

Chementator

C. H. CHILTON

Davison Chemical is getting set to introduce a new product competitive with Linde's molecular sieves. Trade talk has it that Davison will sell material at about half the price Linde is now charging.

Hercules emphatically reaffirms that its polypropylene process uses no Montecatini patents or trade secrets. A recent public statement by a Montecatini official implied that Montecatini know-how had leaked to Hercules via Ziegler and Hoechst in Germany.

Computer control isn't necessarily limited to processing of fluids. Riverside Cement Co. will install an RW-300 digital control computer as first step toward fully automatic control of a cement plant at Oro Grande, Calif.

Pollution rules buffet oil refiners

Los Angeles County Board of Supervisors last month unanimously adopted a rule which restricts the burning of fuel oil in the Los Angeles Basin during the smog season.

Specifically, Rule 62, which has the effect of state law, forbids burning of fuel oil having a sulfur content greater than 0.5% and recommends substitution of natural gas. Smog season is defined as May 1-Oct. 31.

Proponents of Rule 62 say that it will keep out of the atmosphere 350 tons/day of sulfur dioxide and 65-70 tons/day of other pollutants. Fraser Johnstone, University of Illinois chemical engineering professor and consultant to the Los Angeles Air Pollution Control District, supports this view. Johnstone warns that conditions in the city make possible the formation of disastrous acid fogs which "could claim tens of thousands of lives."

In hearings on the rule, Louis McCabe, former director of APCD, labeled Johnstone's statement as "irresponsible."

Also disagreeing violently with APCD is Western Oil & Gas Assn. It has been estimated that natural gas would supplant some 50,000 bbl./day of fuel oil. This comes as a bitter blow to West Coast refiners, already suffering from a heavy surplus of fuel oil.

Nobody expects that a fuel oil of 0.5% sulfur content is economically practical today.

Johnstone says bluntly that "increased costs of fuel must be balanced against the peril of acid fogs." His experimental work at Illinois shows that large (500-900 micron) fog droplets form around nucleating materials of 0.5-1.0 micron. These nuclei, e.g., manganese sulfate and iron sulfate, act as catalysts to oxidize SO_2 to H_2SO_4. Such nuclei are present in industrial atmospheres.

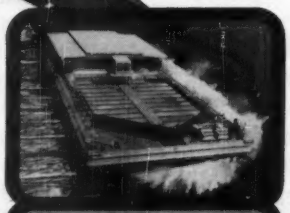
Fundamentally, Johnstone recommended that SO_2 content of stack gases be limited. Control at the source, i.e., the fuel, was apparently considered more practical than removal of SO_2 from stack gases.

Refiners are also seriously concerned about another possible restrictive ruling by

The new corrosion film everyone is talking about!

LIFETIME PROTECTION FOR STEEL

Here is an authoritative film that answers many questions on the theory of corrosion and demonstrates methods by which it is controlled. Presented in color and sound, it ranges from the formation of anodes and cathodes through the use of galvanizing, inhibitors, metallizing, cathodic protection, alloys and protective coatings. You will see how many corrosion problems in industries such as yours are being solved by Dimetcote, a one-coat zinc silicate protective coating. This film will be well worth 19 minutes of your time. To arrange a showing for you and your associates, or to learn when it will be shown in your area, contact any of the Amercoat offices listed below.



Typical audience reactions:

Bishop, Tex.—"Planning fair-sized test after seeing this film."

Louisville, Ky.—"Answers many questions. Second showing arranged."

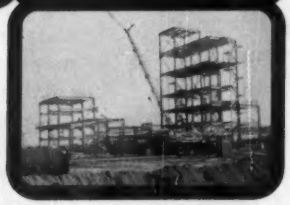
Cincinnati, Ohio—"Key personnel evidenced considerable interest."

Netherlands Antilles—"Both shows led to 45-minute discussions."

Fairport, Ohio—"Very interesting. Will try methods shown."

Las Piedras, Venezuela—"Putting ideas to work in near future."

Bartlesville, Okla.—"Viewed by 42 key men from five divisions."



Answers these and other questions:

What produces electrolytic corrosion?

What factors favor hot-dip galvanizing?

How important is surface preparation?

Can a coating survive a tank fire?

Can rust in tankers be controlled?

Can a coating offer cathodic protection?

What are the corrosion problems on offshore rigs?

What are the advantages of zinc silicate?

How can chemical plants cut painting costs?

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APCD. This one would limit the olefin content of gasoline in an attempt—considered abortive by many—to reduce the amount of smog-contributing olefins exhausted into the atmosphere.

Are students avoiding engineering?

This year's downturn in engineering enrollments has engineering educators disturbed.

With nationwide college enrollments up 5% over last year, engineering enrollments are down by 13%. Expressed another way, engineering students today represent only 8.7% of the total undergraduate population, whereas for the past five years this figure has exceeded 10%. These data come from a survey just made by the government's Office of Education.

What accounts for this situation? Why has the engineering profession lost its appeal to today's youth? Here are two possible answers:

• Some engineering schools have raised their standards of admission and/or performance. At University of Houston, for example, where engineering enrollment fell from 2,174 to 1,836 this year, Dean F. M. Tiller says that tougher math requirements have made entrance more difficult. In addition, 600 engineering students at Houston have been suspended in the past three to four years.

• Although data are lacking, many technically oriented students are swinging to science, ventures Dean W. L. McCabe of Brooklyn Poly. Supporting this view is a report from MIT that Physics is top choice of entering freshmen this year, replacing Electrical Engineering for the first time. And although Chemical Engineering is still third, Mathematics is in fourth position.

Keep an eye on this new process pump

Shell Chemical this month is evaluating its experience with 12 pumps of a revolutionary design installed at its Houston plant during the year.

The new VRO (vertical restricting orifice) pump is the result of the combined efforts of Shell engineers and United Centrifugal Pump Co. (Oakland, Calif.) to design a pump that would meet these basic requirements: Maximum interchangeability of parts; standard mounting dimensions; simple installation and removal procedure; simple maintenance procedures; and moderate capital cost.

Shell's Houston plant has some 1,100 pumps that vary in every conceivable way. These variations include 30 different makes, 85 types of packing, 57 types of mechanical seals and more than 2,500 different spare parts of about 20 types of alloys. The new VRO pump may eventually replace about 80% of the centrifugal pumps now in use, according to Development Engineer V. F. Anderson.

All 12 of Shell's present VRO's are of a single size—3 in. However, a venturi orifice which restricts the discharge from the pump into the line permits the same 3-in. pump to substitute—at some loss in efficiency—for any pump from ¾ in. to 3 in. (United says that 2-in. and 4-in. VRO's are also available.)

Pump is single stage and is line-mounted, with minor pipe supports. With a special fork truck arrangement, Shell can mount a VRO in less than an hour. A defective pump can thus be quickly replaced with a spare, then repaired in the shop under favorable working conditions. Simplified design and interchangeability cut down tremendously on the stock of spare parts needed for maintenance of conventional pumps.

Refractory coatings via plasma spray

A new frontier in high-temperature materials of construction is being carved out by the recently developed technique of plasma-spray coating.

Linde Co. last month announced its entry into this new field. Earlier this year, Giannini Plasmadyne Corp. (Santa Ana, Calif.) and Plasma Flame Corp. (Westbury, N. Y.) came out with similar developments. Whereas the latter two firms aim to sell plasma-spray equipment, Linde will limit itself to custom spray-coating and fabrication services.

Plasma spraying takes its name from the high temperatures (15,000-30,000 F.) generated by a high-intensity electric arc. In basic operation, it resembles conventional (5,000 F. maximum) flame spraying. A refractory material, in either powder or wire form, is fed into the flame, which is directed at the object being coated. Here's how it differs from flame spraying:

• Material being sprayed vaporizes in the plasma flame. Resulting deposit shows an

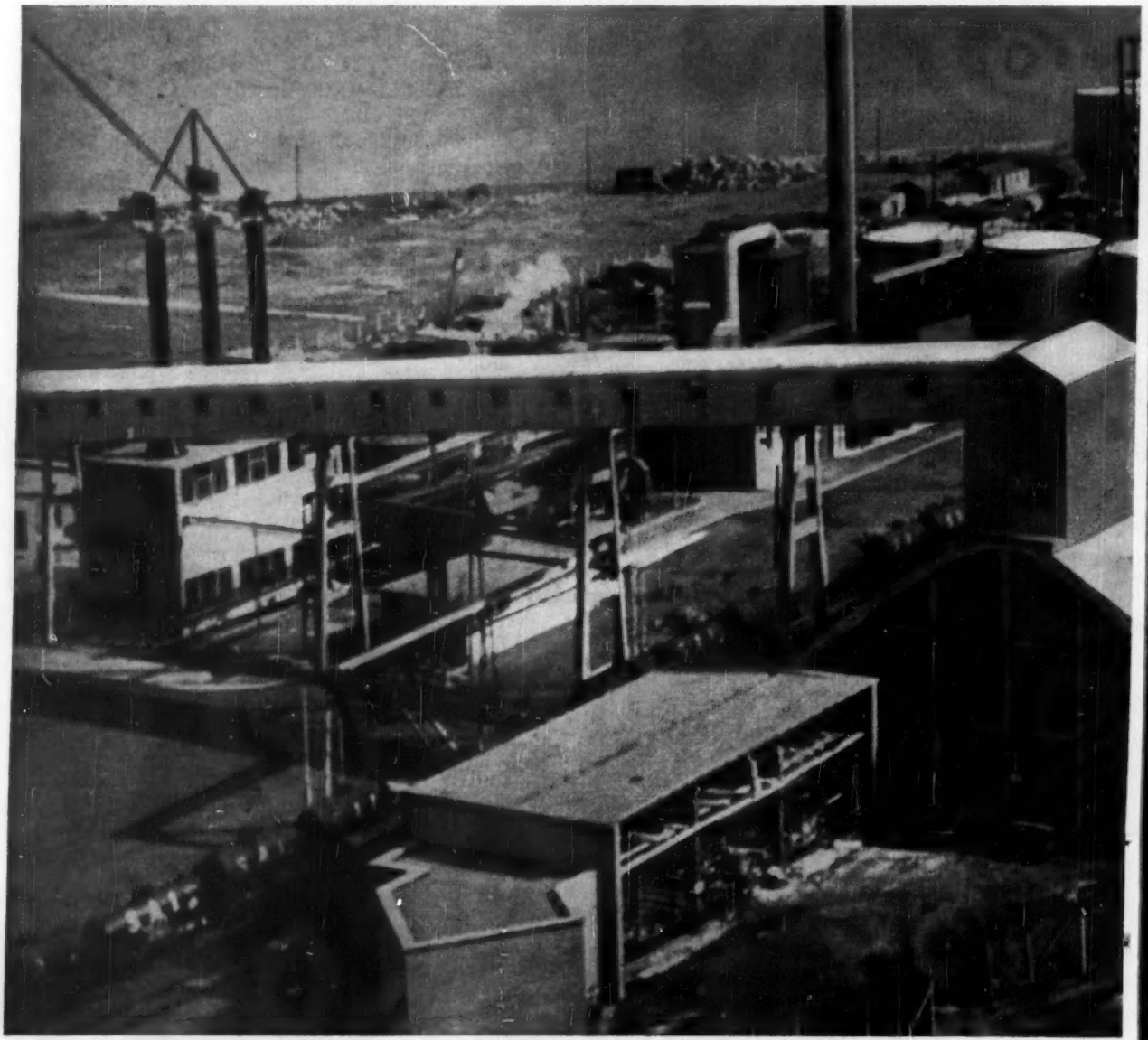
(Continued on page 70)

New 500 TPD Concentrated

for Scottish Agricultural Industries, Ltd.

Earlier this year, Scottish Agricultural Industries, Ltd. inaugurated their new 8.5 million dollar plant at Leith, Scotland, for producing ammonium phosphate based complete granular fertilizers. The new plant includes three main process units—sulfuric acid production, phosphoric acid production and a fertilizer production section. The fertilizer section, designed by Dorr-Oliver, utilizes the Dorrco Granular Fertilizer Process.

This is another example of the world-wide recognition of Dorr-Oliver's 41 years of experience in the field of concentrated fertilizer production, via the wet process of manufacturing phosphoric acid. Other D-O designed plants completed or in course of construction during the past two years include installations in India, Venezuela, England, Norway and Montana, as well as a 200,000-ton per year triple superphosphate plant in Florida.



Fertilizer Plant On Stream

Granulation section designed by

Dorr-Oliver engineers are qualified to handle all phases of fertilizer plant design—from preliminary laboratory studies and economic analysis to finished construction and supervision of initial operation.

If you are considering operations in this fast growing field, it will pay you to check with Dorr-Oliver. Write for Bulletin No. 8000, or better still, let us send an engineer to discuss your problem from the standpoints of both economics and process.

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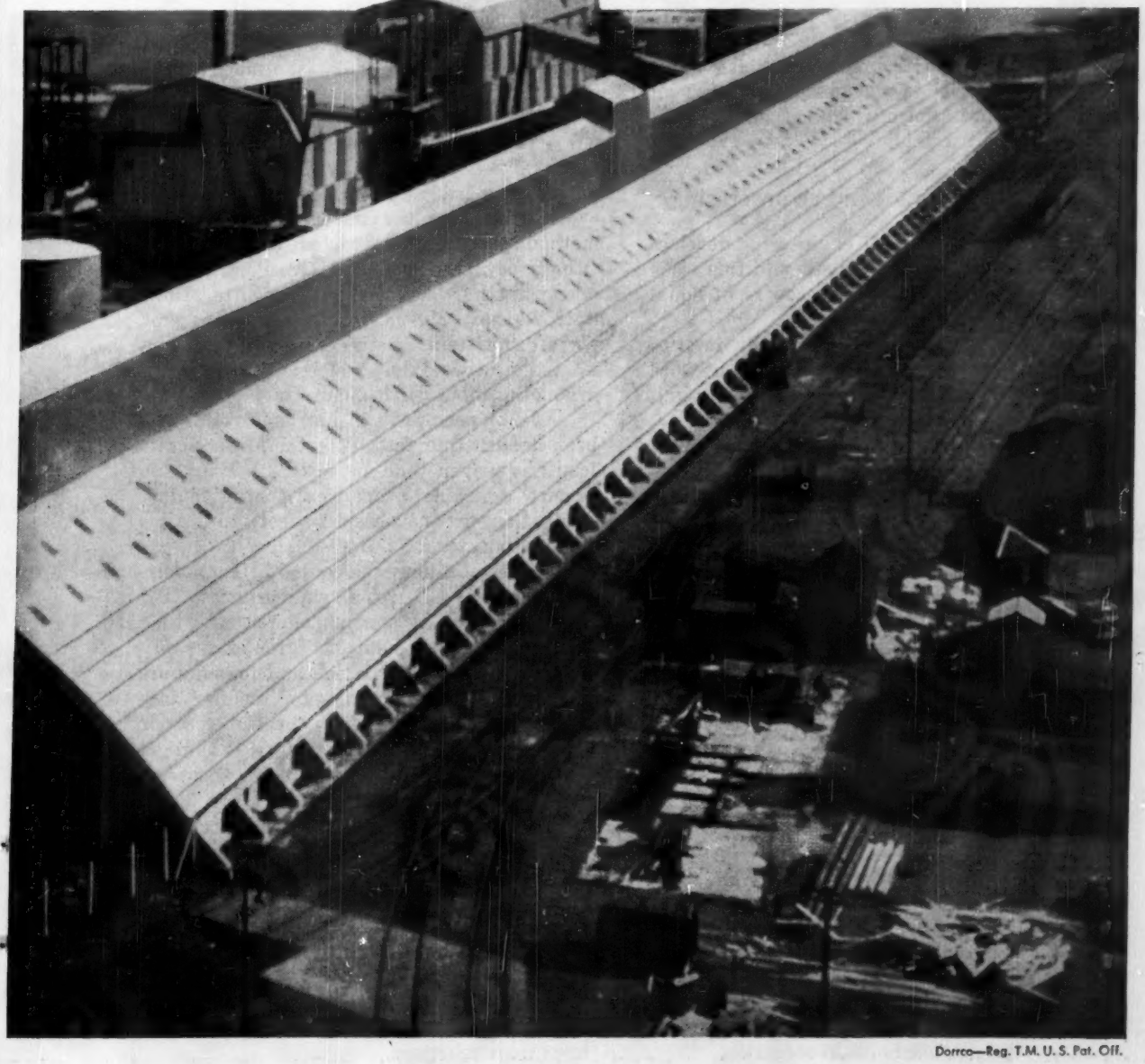
Aerial view of the completed concentrated fertilizer plant for Scottish Agricultural Industries, Ltd. Dorr-Oliver designed Granulation Section is located in building in front of smokestack at left.



Dorrco—Reg. T.M. U. S. Pat. Off.

improved surface-to-coating bond, has high density and low porosity.

• Materials of higher melting points can now be sprayed.

• Use of non-oxidizing medium permits spraying of materials (e.g., molybdenum, zirconium diboride) which would suffer oxidation in ordinary flame spraying. Plasma-sprayed coating is said to be as pure as the material fed to the plasma flame.

Immediate applications are seen for plasma spraying in the missile and rocket fields. Coatings of tungsten, palladium, metal oxides or cermets—resistant to heat, corrosion and erosion—may now be sprayed onto nose-cone or nozzle surfaces. And Linde offers a fabrication technique in which a refractory material is plasma-sprayed onto an expendable brass form which is then dissolved away with nitric acid.

Ad—, absorption vie in gas processing

Today's fast pace of engineering developments is illustrated by our story in this issue on dry adsorption units for recovery of liquid hydrocarbons from natural gas.

This story (p. 72) was already in type when Parkersburg Rig & Reel Co. sent us word of its latest improvement—a three-tower unit designated the DAU-3.

Object of the third tower is to permit a better balance of cycle times than can be obtained with two towers. While one tower adsorbs, the second is cooling and the third is heating. With this arrangement, says Parkersburg, a three-tower unit has twice the capacity of a two-tower unit.

And meeting head-on the competition of glycol absorption units, Parkersburg has also come out with its own version of glycol dehydration. This new unit, called the Super-Dryer, is said to get low dewpoints heretofore unobtainable economically with small packaged absorption dryers.

Dewpoint of product gas leaving the absorber is a function of the dryness of triethylene glycol fed to the absorber. Glycol quality, in turn, is dependent on how the glycol stripper is operated. Normally, glycol is stripped to 98.0-98.5%. To get above this, you must raise reboiler temperature or operate under vacuum. Higher temperature increases glycol decomposition, results in greater loss; vacuum involves expensive equipment, is not suited to unattended oilfield operation.

In the new Super-Dryer, the glycol is stripped to 99.7% simply by bleeding a low-pressure stream of dry natural gas into the bottom of the stripping column. The resultant lowering of partial pressure has the same effect as vacuum but avoids the costs and problems of vacuum operation. The 99.7% glycol, says Parkersburg, can get dewpoint depressions well over 100 F., or can produce a standard 65 F. dewpoint depression with lower reboiler temperatures.

New catalysts simplify urethane foaming

New polymerization and foaming catalysts promise to make polyether-based urethane resins as easy to produce as the more-expensive polyester-based variety.

Mobay Chemical has just come out with a new organotin-containing catalyst—rumored to be dibutyl tin di(2-ethyl hexoate)—which makes it possible to turn out polyether-isocyanate foams via the conventional "one-shot" method previously restricted to polyesters. Other isocyanate producers (Du Pont, Allied) and polyether suppliers (Wyandotte, Dow, Carbide) have also been researching one-shot polyether systems. Carbide, in fact, has come up with a new catalyst which also involves an organotin, dibutyl tin dilaurate.

Use of polyethers in urethane resins has been accelerating fast. Polyethers are significantly cheaper than polyesters. They also impart desirable properties (better aging, elmination of "snow-crust" effect) to flexible foam products.

But wheel-horse polyethers (e.g., polypropylene glycol) react via secondary hydroxyl groups—at a much slower rate than polyesters, whose hydroxyl groups are primary. When polymerization and foaming are done together, polymerization reaction lags behind foaming. Viscosity in the reaction mass does not develop fast enough, so that gas meant for producing foam bubbles shoots up to the surface and escapes.

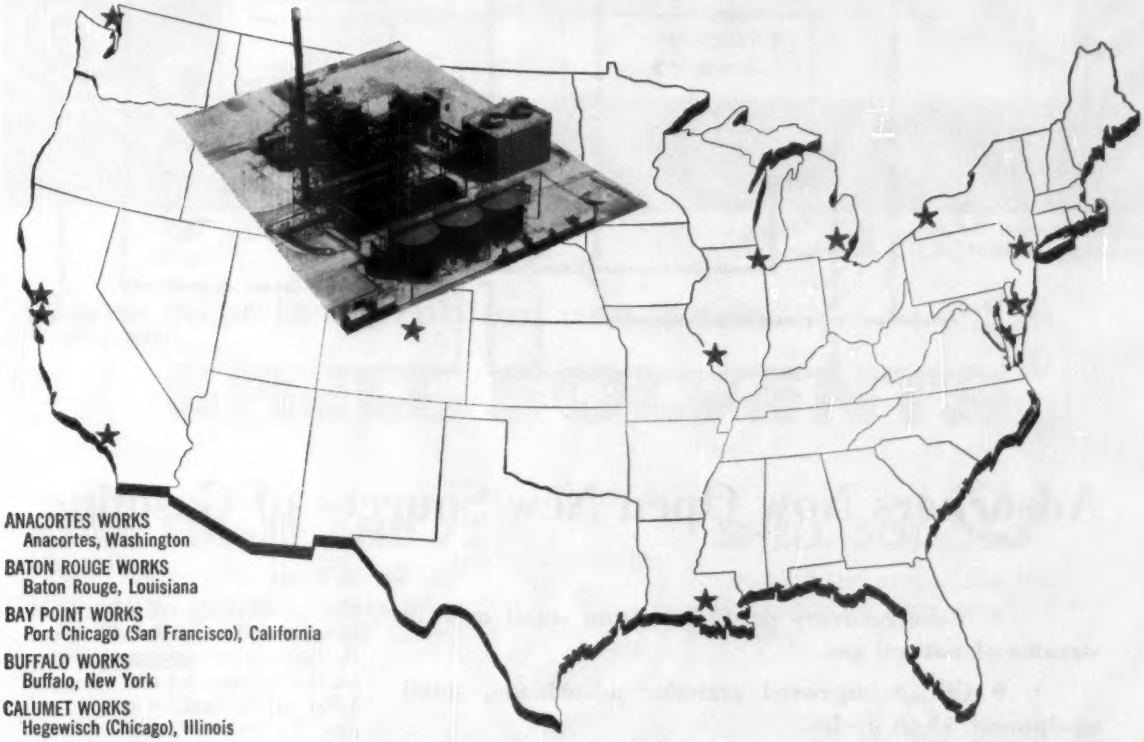
Prepolymerization of the isocyanate and polyether gets around the viscosity problem. Still, the truncated foaming reaction develops a temperature of only about 70 C., not enough to provide the sort of built-in cure possible with the 100-130 C. of polyester reactions.

The new catalysts are designed to eleminate both the prepolymerization and oven-curing steps heretofore needed for polyether-isocyanate reactions.

An important message to every sulfuric user interested in spent acid recovery...

12 GENERAL CHEMICAL Plants

are equipped to handle spent acid for you



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General Chemical provides industry with sulfuric acid from 18 producing points, located in major centers of commerce from coast to coast. Of these, 12 are equipped to handle spent acid—providing unmatched experience, service and facilities to customers interested in spent acid recovery.

Relatively high strength, impure sulfuric presents many problems of handling and disposal. With General's help you may be able to turn this costly nuisance into an economic asset.

Whether we can help you or not depends on a number of factors: The acid strength . . . The nature and amounts of contaminants . . . The tonnage available . . . The distance of your location from our nearest plant. Generally, spent acids containing 70%-80% sulfuric acid, or higher, can be reclaimed if they do not contain impurities harmful to the equipment.

Our experience in solving spent acid problems of every kind is at your service. For further information, write or call your nearest General Chemical office.

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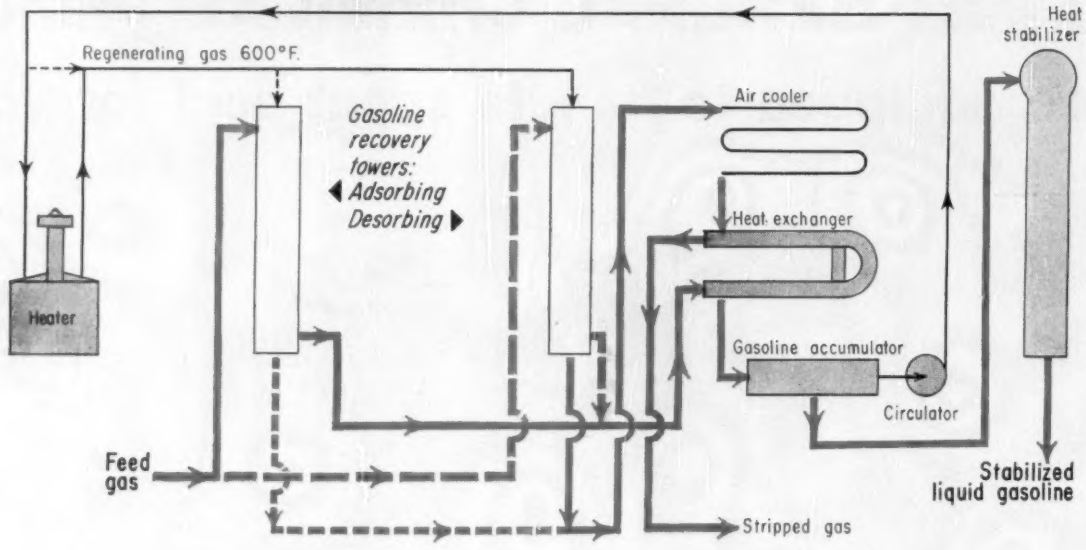
Dryex **Adsorption** — **Desorption** Strips Gasoline From Gas



Adsorbers Now Open New Sources of Gasoline

• Make recovery profitable from small or lean streams of natural gas.

• Utilize improved granular adsorbents, small equipment, short cycles.

• Desorb at high temperature to maintain high activity, long life.

Commercial evidence is mounting of adsorption's re-entry into the field of hydrocarbon recovery from natural gas.

Four companies—Delta Tank & Mfg. Co., National Tank, Jefferson Lake Sulphur and Parkersburg Rig & Reel—have adsorption-based package units. Each has made commercial installations, most of them within the past two years. Units also dehydrate, as incidental step.

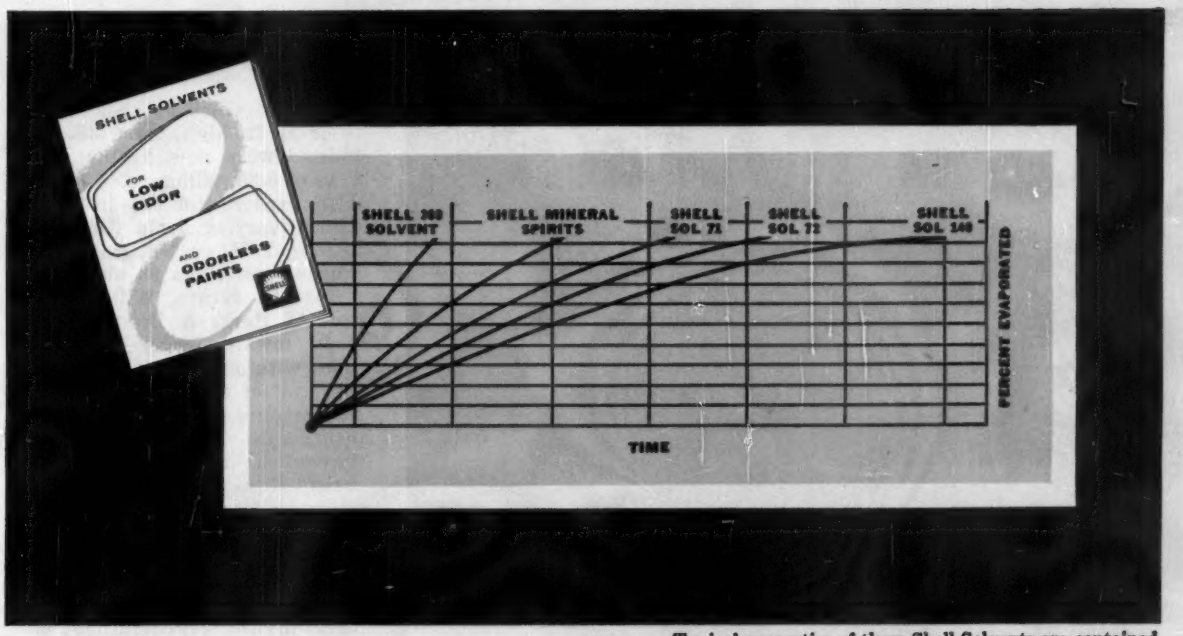
Charcoal adsorption plants used during the early years of the natural gasoline industry have long since been displaced by less bulky, more efficient oil absorption and refrigeration plants.

But now, with improved granular adsorbents, smaller equipment, and process cycles running around 45 min. rather than 2-4 hr,. the new adsorption units can offer advantages tailored to a neglected segment of the market: About 10,000 million cu. ft./day of gas from streams untreated because they were too small or too lean to justify oil absorption or refrigeration.

▶Markets Well Sighted—Payout of the new units is most attractive when the stream treated is between 10 and 40 million cu. ft./day and its raw gasoline content is between 0.1 and 0.3 gal./1,000 cu. ft. (gal./M cu. ft.) of gas. To make it worthwhile to treat a 0.3-gal./M cu. ft. stream with refrigeration or oil absorption, size of stream would have to range between 50 and 100 million cu. ft./day.

▶Three Have Fixed Beds—For Delta, National and Parkersburg units, adsorption proceeds in a fashion generally similar to the early charcoal natural-gasoline plants and conventional dry-bed dehydrators. Two or more fixed beds of solid granular adsorbent material alternate to adsorb hydrocarbon fractions continuously from the gas stream. While one bed is on stream, the alternate bed is stripped of product, thereby reactivating it.

▶One Has Moving Bed—Jefferson Lake Sulphur's Rotosorber



Typical properties of these Shell Solvents are contained in booklet shown. It will be mailed on request.

Where odor is a problem use these

SHELL SOLVENTS

SHELL SOL 71 AND 72

. . . have no odor, are ideal for interior finishes, polishes and cleaners. Shell Sol 71 offers slightly faster evaporation.

SHELL SOL 360

. . . much faster evaporation than mineral spirits, low odor, over 100° F. flash point.

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. . . a high-flash, slower drying solvent with unusually low odor.

SHELL MINERAL SPIRITS

. . . traditional distillation range, solvent power and drying. Mild odor.

These solvents are recommended for low odor and odorless products.

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DRYEX 36-in. gasoline recovery unit, heater (left), adsorbers (right).

is unique: It alone uses a moving bed of adsorbent.

Two Rotosorber installations have been operating for several years. With this background of operating experience, Jefferson Lake tells *CE* that the unit is now right at the brink of full commercialization.

▶ **Long-Lived Adsorbents** — But all four of the new units utilize high-temperature (600 F.) natural gas to regenerate the adsorbent material. By contrast, old-style charcoal plants used 350-400 F. steam. At such low regenerating temperatures, adsorptive capacity decreased rapidly.

Relatively small beds of activated material used in the new units will heat quickly and uniformly to regeneration temperature, then cool rapidly down to adsorption temperature. This permits a relatively long operating life, about one year, for the adsorbent.

▶ **With or Without LPG**—Parkersburg aims only to recover pentanes-plus; the others can be set up to recover liquefied petroleum gas (LPG), too. Also, these others use closed-cycle regeneration, said markedly to improve efficiency of hydrocarbon recovery.

According to a National Tank spokesman, you lose a certain amount of recovered product by feedback to the main gas stream, unless you use closed-cycle regeneration. Even though a closed-cycle system costs more to install, increased output more than offsets the added expense, except when gas contains less than 0.1 gal./M cu. ft.

▶ **Product Recovery** — Over-all recovery of any adsorption unit is influenced greatly by how well the unit condenses hydrocarbon vapor stripped from the adsorbent during regeneration. Efficiency of condensation is very sensitive to factors such as process flow design, heat balance design, composition of the enriched regeneration stream, condensation temperature and pressure.

Representative Delta Tank installations extract 60-90% of the pentanes-plus fraction, condense 95% of material extracted. On recovery of butanes and propane, condensation is somewhat less effective.

▶ **Commercial Units**—Most comparable in design are the Delta unit which boasts seven operating installations and the National plant with six in operation. All went on stream within the past two years, all recover pentanes-plus only.

Called Dryex, Delta Tank's unit was developed jointly by Delta and Parks & Dow, engineering consultants. It's fully automatic, self-contained and skid-mounted.

For gasoline recovery, unit has only two adsorption towers filled with silica gel. Standing 10 or 15 ft. high, these 36- or 48-in. towers now handle gas flows of 6-35 million cu. ft./day. With product content in feed stream varying from 0.098 to 0.313 gal./M cu. ft., recovery ranges from 19 to 93 bbl./day.

For the future, Willard M. Dow of Parks & Dow sees a trend toward larger installations with greater interest in two-product units for LPG and raw gasoline. Such units would incorporate a second pair of towers filled with activated carbon to recover LPG.

▶ **Process Route**—In addition to the towers, the Dryex assembly includes heat exchangers, an extracted-liquid accumulator vessel, a gas pump and motor, a direct-fired regeneration-gas heater.

Main gas stream, free of entrained liquid, flows down extraction tower, through gas-to-gas exchanger back to pipeline. Regeneration gas stream, driven by pump, recirculates continuously through heater (except during cooling period), tower, convection-cooled gas-to-air heat exchanger, gas-to-gas exchanger and liquid accumulator.

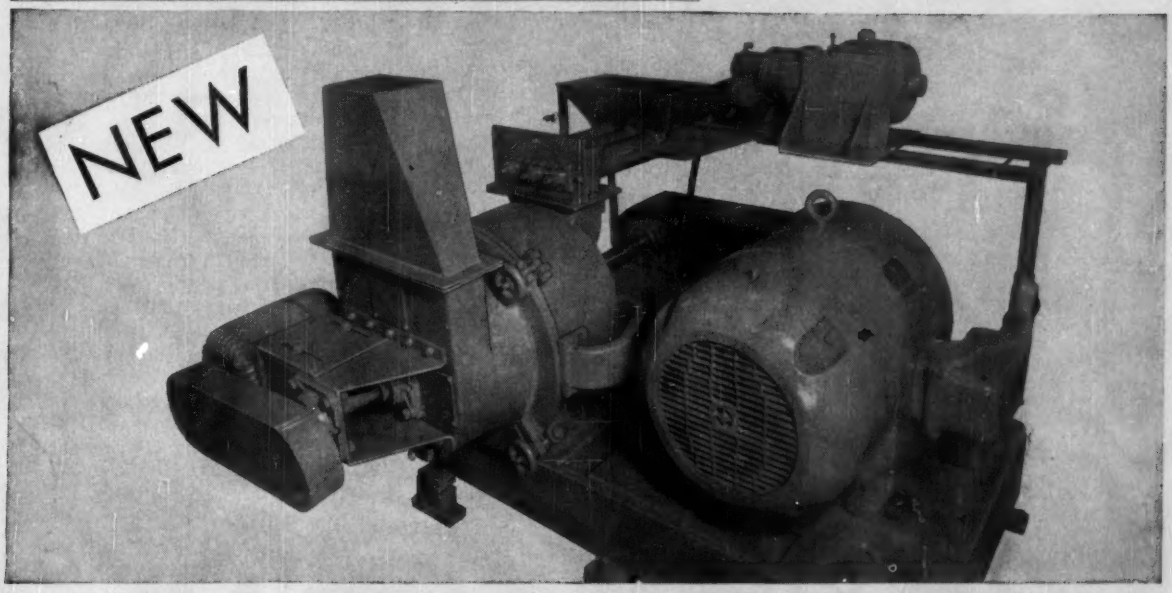
Sequencing of gas flow is controlled automatically through pneumatically operated three-way valves.

Recovered hydrocarbon liquids go to heat stabilization tower which produces stable lease-tank gasoline.

▶ **Low Cost**—Cost of the Dryex adsorption assembly complete with controls and granular adsorbent ranges from about $1,000 to $1,600/daily bbl. of gasoline at recovery rates of 40 to 200 bbl./day. Installation, including cost of auxiliary equipment such as separators and storage tanks, costs about 10 to 15% as much as the packaged process unit.

Direct operating costs for fuel gas and electricity are 15¢ or less per barrel of recovered product.

If main gas stream can tolerate pressure drop of about 25 psi., operator may cut utility charges in half by using a turbine drive on the recirculating blower, rather than an electric motor.



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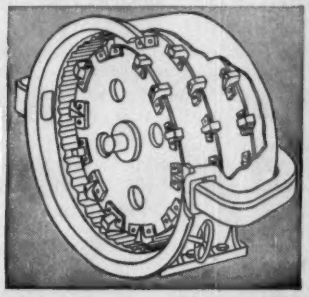
The PULVOCRON . . . An Air Attrition Impact Pulverizer and Classifier with Controlled Radial Inward Air Classification.

Now in one compact unit you can have a pulverizer and a classifier plus an automatic feeder, with separate controls over each. This assures positive particle size control and high capacity over a wide range of products. The Pulvocron will produce particle sizes from a range of 99% less than 5 microns or as coarse as 50 mesh, depending on the material and desired results.

The grinding chamber contains three adjustable plates with twelve staggered beaters on each. It also features added versatility through interchangeable liners of corrugated, perforated or smooth finish, plus variable rotor stator clearances.

The Classifier unit is on a hinged section with quick-open locks for simplicity of operating adjustment or cleaning.

Material is both ground and classified through high centrifugal pressures set up by the beater and classifier plates. The Pulvocron is designed with oversize returns for automatic feed back of any oversize for further grinding.



Grinding chamber with adjustable plates, removable liners and oversize returns.

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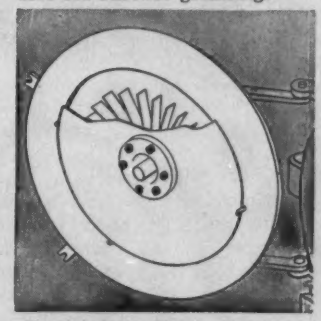
Strong-Scott offers you a modern up-to-date laboratory containing specialized testing equipment. This is backed by an expert engineering staff to furnish layout and design service at no additional cost to you.



Classifier Unit with separate motor. Swings open as a hinged section with quick open locks.

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The **Strong Scott** Mfg. Co.

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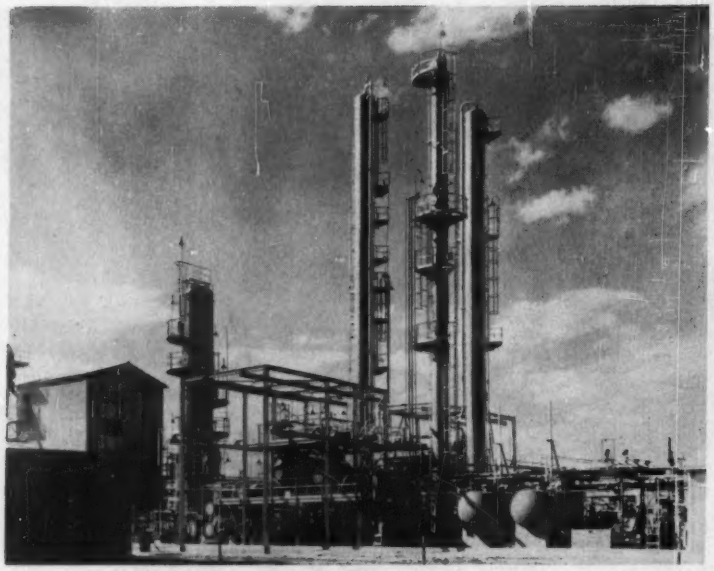


BORIC ACID enters this unit in first process step as . . .

Boron Fuels Head for Volume Output

Boron-based jet fuel will be produced in "tonnage quantities" next year as Callery Chemical Co. brings on stream additional process units at the Navy's new $38-million plant at Muskogee, Okla.

When the plant was opened briefly to visitors last month, three of the four processing areas and two of the three steam generators were still under construction. Several months' work is still ahead before HiCal fuel begins to trickle forth.

▶ **Strictly Military**—High cost and tight secrecy lend a decidedly military aura to the Muskogee project. Enough is known about the general nature of the boron fuel program, however, to permit some safe generalizations.

Cost of the product will be high; on a commercial basis, selling price would probably be on the order of $10/lb. And a highly integrated plant like Callery's would have a turnover ratio (annual value of product divided by plant investment) of about 1.0. These figures indicate an estimated production rate of 3.8 million lb./yr.

Plant output will be used for extensive test work on various types of propulsion systems, such as turbojets and ramjets.

▶ **Production Route**—Basic raw materials for HiCal are boric acid, sodium, methanol, ethanol and methane.

First step is production of methyl borate by reaction of methanol with boric acid. This step involves some plain and fancy distillation operations (*see photo above*).

In another process area, sodium is reacted with hydrogen to make sodium hydride. The two intermediates, methyl borate and sodium hydride, are then brought together in an undisclosed manner to make diborane (B_2H_6).

In the final operation, diborane is alkylated with ethylene and polymerized to yield the liquid HiCal product. Specific identity of the product to be made at Muskogee hasn't been revealed; one report points to triethyl decaborane.

▶ **Process Auxiliaries**—In an auxiliary $3.5-million gas plant, methane is steam-reformed to produce hydrogen for the sodium hydride step. Nitrogen and carbon dioxide are made by burning more methane in an inert-gas generator. Nitrogen is used throughout the plant as a blanketing agent; CO_2 enters the fuel process in an unspecified manner.

In another unit, ethanol is cracked to make ethylene for borane alkylation.

Thermodynamically, a tremendous amount of energy has to be expended to make each pound of high-energy boron fuel. Callery says that the gas-fired steam plant at Muskogee is "nearly 25 times larger than the steam plant in a petroleum refinery of comparable size." In fact, availability of natural gas and cooling water (Arkansas R.) weighed heavily in selection of the 1,300-acre plant site.

Process for Silane Is Safer, Cheaper

German chemical manufacturer, Metallgesellschaft AG, claims that it has developed a process for making silane (SiH_4) that is cheaper and safer than competing flowsheets. Silane is starting material for a number of silicon products and polymers and is used in making transistors.

Basis of process is reaction of magnesium silicide (Mg_2Si) with ammonium chloride in liquid ammonia. Reaction proceeds rapidly at atmospheric pressure yielding over 50% silane which leaves reaction mixture as a gas along with ammonia vapors. Gas mixture is cooled with solid CO_2 to condense out ammonia and then silane is liquefied by cooling against liquid nitrogen after washing with dilute HCl. Liquid silane is further purified by distillation.

Process is readily adapted to a closed system—a necessary feature since silane explodes on contact with air. Adding small amounts of carbon dioxide, nitrogen, ethylene or hydrogen to liquid silane renders it safe to handle without danger of self-ignition.

To produce diethyl-silane, liquid silane and liquid ethylene are reacted in an autoclave at 570 F. Dichloro-silane is made by reacting liquid silane with silicon tetrachloride and a little aluminum chloride at 570 F.

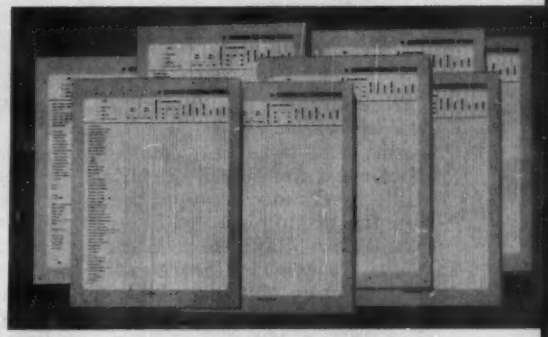
Now you can predict service life because Byers PVC Pipe Engineering brings a factual approach to piping system design

FACT: 400 corrosion resistance ratings are available for Byers PVC Pipe

The ability of Byers PVC Pipe to handle various corrosive media is down in black and white. There are a number of tables available from Byers Engineering Service Department listing corrosion resistance ratings. Actual laboratory tests helped to determine these ratings. And we present them on a comparative basis with several metallic pipe materials.

Since ratings appear only for 72°F and 140°F, these tables do not show all applicable ranges for Byers PVC Pipe. So if applications arise where you need more information, at a specific temperature and concentration, check with us.

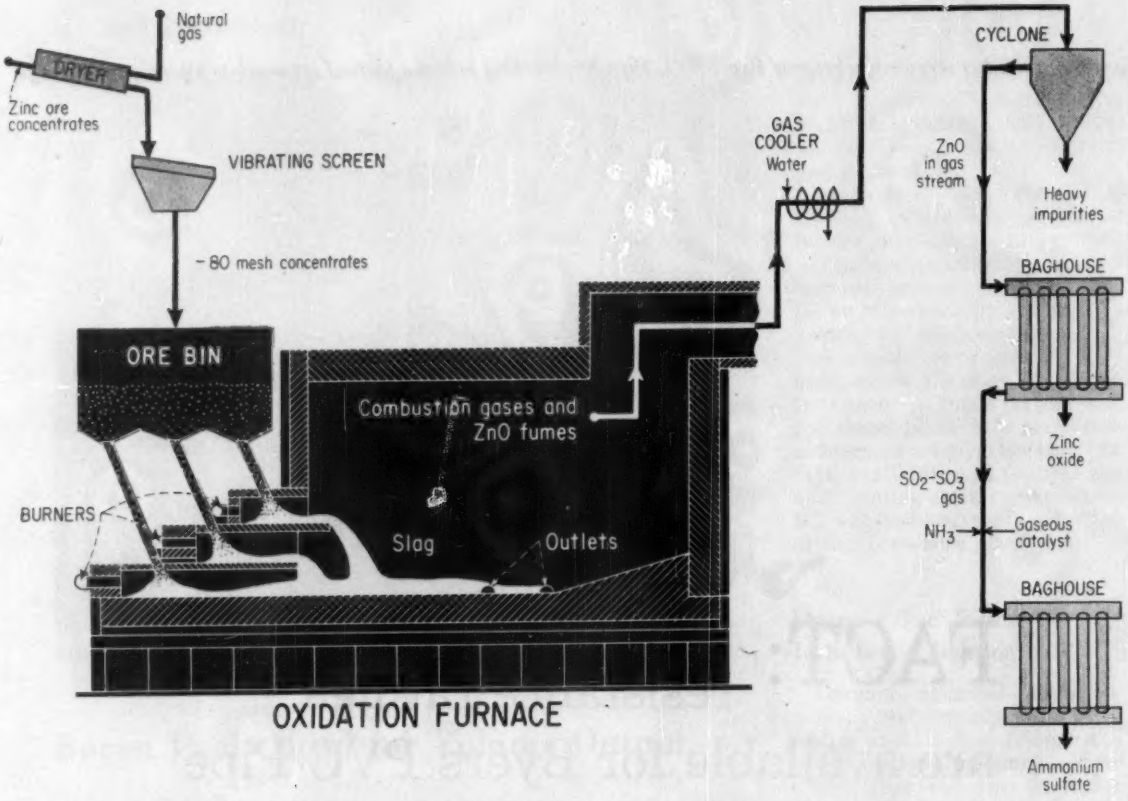
Remember—as in metals—concentration, temperatures and stress influence corrosion rates of PVC. Type I PVC displays considerably greater corrosion resistance than Type II, which is best where high impact resistance is the prime consideration. More of this story is available from the Byers field service representative. Call him, soon. **A. M. Byers Company, Clark Building, Pittsburgh 22, Pennsylvania.**



Resistance ratings are divided into four categories: E for excellent, G for good, L for limited, and U for unsatisfactory. In applications where PVC is rated as "good" and "limited" it will still display considerable resistance, in most cases higher than that of metal pipe materials.

BYERS PVC PIPE

Write our Engineering Service Department for copy of this new 32-page illustrated catalog on Byers PVC Pipe.



Flash Oxidation Slashes Metallic Oxide Costs

• Reduces capital investment 80%, cuts production cost 40%.

• Uses either sulfide-ore concentrates or mill slag that contains metal.

• Converts SO_2-SO_3 gases to ammonium sulfate in secondary step.

New flash oxidation furnace and a secret gaseous catalyst form the technical core of Northwest Refining & Chemical Co.'s simplified continuous process for making zinc oxide and ammonium sulfate. Firm's novel process is incorporated into its new $392,000 plant at Spokane, Wash. (*Chem. Eng.*, Feb. 1957, p. 162).

Northwest's process is quite flexible: Plant can make zinc sulfate—instead of zinc oxide and ammonium sulfate—if market conditions dictate. Too, by adding a pulverizing mill, plant will be able to process zinc slags from mill wastes that until now have been uneconomical to handle. Pres. Allen says that plant can produce oxides of other nonferrous metals like copper and lead by altering furnace temperature.

Process converts zinc sulfide ore concentrates to zinc oxide in a single flash oxidation (eliminating the usual preliminary roasting step) and utilizes the SO_2—SO_3 off-gas to make ammonium sulfate by reacting with ammonia and an unidentified catalyst.

Plant capacity is 24 tons/day zinc oxide and 18 tons/day ammonium sulfate. It is also set up to mix 120 tons/day mineral fertilizers (e.g., zinc, calcium, sulfur, nitrogen).

▶**Simplicity Means Savings**—Northwest's Pres. John A. Allen now estimates that his firm saved 80% on capital investment by utilizing flash oxidation process instead of alternate routes. (See *Chem. Eng.*, May 1957, p. 168 for process that makes zinc oxide by oxidizing metallic zinc vapor.)

Too, Allen says that production cost of 6.13¢/lb. of zinc oxide is as much as 4¢/lb. cheaper than competing processes. Plant's zinc-oxide output (about 99% pure) is being sold to paint manufacturers for white pigments; ammonium sulfate is going to fertilizer dealers.

▶**One Step Yields Oxide**—Northwest's patented reverberatory furnace (U. S. 2,827,370) flash oxidizes the dried zinc sulfide concentrates into three components: finely divided zinc-oxide fume, heavy impurity bearing slag, and combustion gases.

Dry concentrates minus 80

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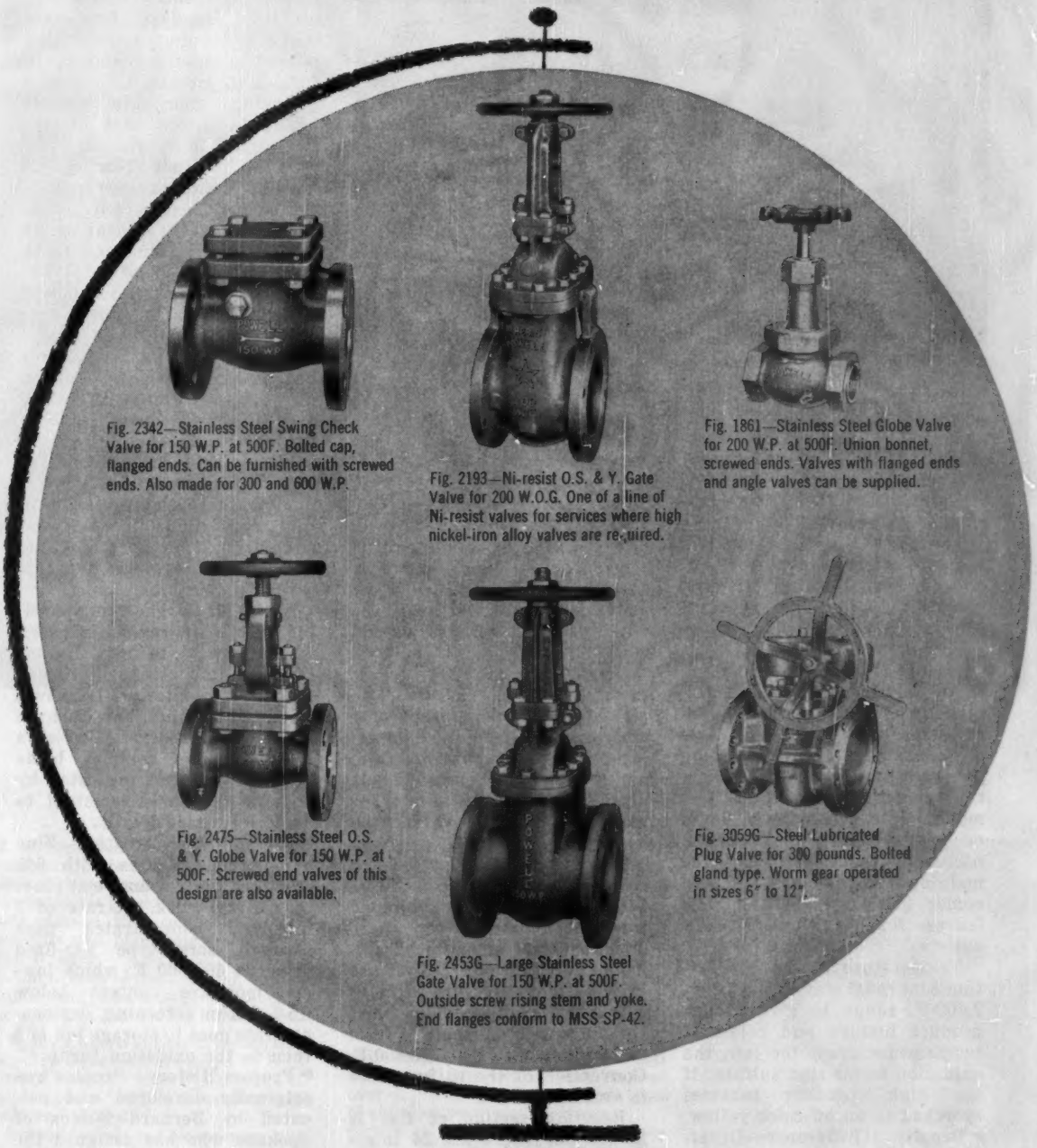

Fig. 2342—Stainless Steel Swing Check Valve for 150 W.P. at 500F. Bolted cap, flanged ends. Can be furnished with screwed ends. Also made for 300 and 600 W.P.

Fig. 2193—Ni-resist O.S. & Y. Gate Valve for 200 W.O.G. One of a line of Ni-resist valves for services where high nickel-iron alloy valves are required.

Fig. 1861—Stainless Steel Globe Valve for 200 W.P. at 500F. Union bonnet, screwed ends. Valves with flanged ends and angle valves can be supplied.

Fig. 2475—Stainless Steel O.S. & Y. Globe Valve for 150 W.P. at 500F. Screwed end valves of this design are also available.

Fig. 2453G—Large Stainless Steel Gate Valve for 150 W.P. at 500F. Outside screw rising stem and yoke. End flanges conform to MSS SP-42.

Fig. 3059G—Steel Lubricated Plug Valve for 300 pounds. Bolted gland type. Worm gear operated in sizes 6" to 12".

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NORTHWEST's Pres. Allen shows how process is controlled from panel.

mesh containing 48-60% zinc and less than 0.5% moisture feed via vibrating feeder into combustion-zone tunnels through baffles that assure intimate contact with hot gases.

The finer particles burn in suspension forming zinc oxide and fine slag. Both remain suspended in the rapidly moving combustion gas stream.

Heavier ore particles drop onto the tunnel hearths. As they oxidize, these particles give up fine zinc oxide to the gas stream.

With zinc content depleted, particles on the hearths reach their melting point. In the molten state, this material flows out of the tunnels onto furnace bottom where most of the remaining zinc oxidizes and becomes gas-borne. Molten slag leaves furnace through side outlets.

Temperature in the combustion zone must stay in the 2,200-2,400-F. range to give proper product texture and color. If temperature drops too low, the oxidation forms zinc sulfate; if too high, product becomes scorched to an off-color yellow.

▶**Density Difference**—Difference in density between zinc oxide fume and the heavier suspended slag is exploited to separate the entrained solids. Most of slag drops out as gases flow over a set of baffles at rear of furnace.

Gases with the remaining suspended particles then flow out into a 42-in.-dia. flue surrounded by a forced-feed water-cooling jacket 24 ft. long. Most of the fly ash drops out here.

Gases then flow through a second-stage cooler—three cone-shaped, water-carrying copper coils mounted end to end inside the flue. Total length of ¾-in. tubing in coils is around 66 ft.

Gases, now at 400 F., flow through a 30-in.-dia. steel flue pipe to a cyclone separator where zinc sulfate and remaining heavy solid impurities drop out. Effluent gas from cyclone is piped to baghouse where fiberglass bags filter zinc oxide from gas stream.

▶**Enter Secret Catalyst**—From zinc oxide baghouse, the SO_2—SO_3 combustion gases are piped through another flue where stoichiometric amounts of ammonia and gaseous catalyst are injected from pressure tanks.

Sulfur dioxide is oxidized and combines with ammonia to form ammonium sulfate at 700-800 F. Conversion of the sulfur gases is around 80%.

Reaction section of flue is 36 in. dia. There are 24 injection nozzles with 0.01-in. openings arranged in two circular bands of 12 each in a 36-in.-long section of flue.

Ammonia and catalyst are injected through same nozzles. Injection rate is altered manually depending on sulfur content of ore processed, usually ranging from 50 to 300 lb./hr. anhydrous NH_3.

Although Northwest won't reveal the identity of its SO_2-oxidation catalyst, firm says that it is definitely not NO_2 that is used in the old chamber sulfuric acid process.

Product ammonium sulfate finally is filtered out of gas stream in bag house.

▶**Do It Yourself**—Northwest's novel oxidation furnace was designed and constructed by the company itself. Measuring 12 ft. wide, 24 ft. long and 12 ft. high, it has 10-in. firebrick lining and 16-in. rear fire wall, will handle 1.5 tons/hr. of ore concentrate.

Five oil-fired burners supply heat to the combustion zone; in near future firm will switch over to natural gas fuel. Once furnace reaches operating temperature level, oxidation of the ore supplies most of heat.

Four thermocouples, two in the combustion chamber and two in the flue, actuate fuel controls to regulate temperature.

Sketch of furnace on preceding page is diagrammatic, based on patent drawings. Rather than an actual representation of the furnace interior, it shows, in simple fashion, how furnace operates. President Allen says that furnace's complex baffle system is not yet protected by patents and so is reluctant to divulge furnace details.

▶**Preliminary Treating**—Zinc sulfide concentrates with 6% moisture content arrive at plant by rail or truck. At rate of 2 tons/hr., concentrates pass through screw-type gas-fired dryer at 600-800 F. which lowers moisture content below 0.5%. After screening, dry concentrate goes to storage bin and then to the oxidation furnace.

▶**Process History**—Process was originally developed and patented by Bernard Wilcox of Spokane who has assigned the patent rights to Northwest Refining & Chemical Co. under a lease-royalty agreement.

New plant went into operation only after seven years' experimentation including four years' of pilot evaluations at Wallace, Idaho.

Now protect product purity, hold down costs two ways with these U. S. Steel rust-inhibited drums

U. S. Steel rust-inhibited drums give maximum protection because they are made with extra care. Every head, shell and bottom is precisely formed, chemically cleaned, then coated inside and out with zinc phosphate – all before final forming.

And to each of these rugged, durable drums–and pails, too–U. S. Steel tacks on two extra purchasing advantages:

1. Today's widest variety of carbon steel shipping containers is offered by U. S. Steel. Capacities from 2½ through 57 gallons, plus a full line of stainless-steel pails and drums.

Special linings and closures are supplied to your specification. Unsurpassed color-decorating facilities are available–all to assure you of a container best suited to your needs.

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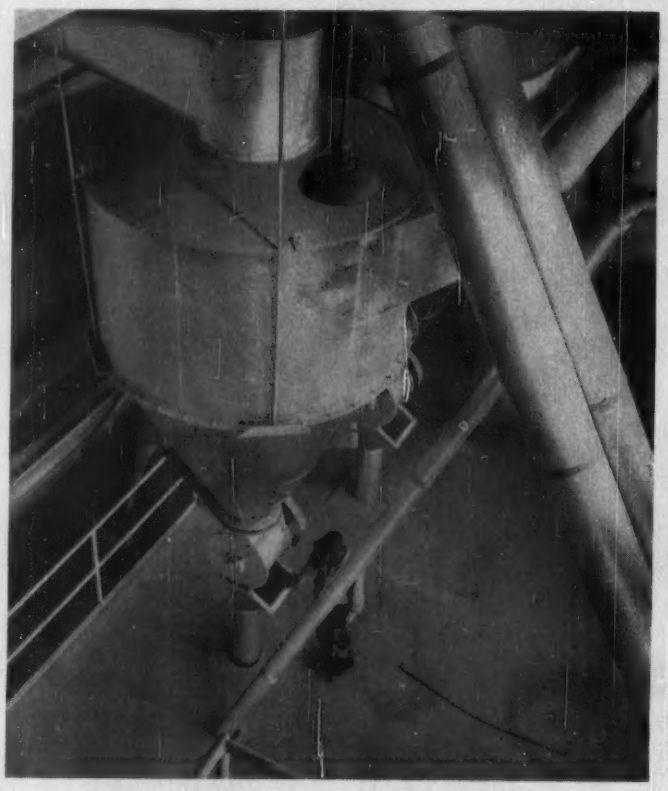
United States Steel Products Division

USS TRADEMARK



Cyclone Winnows Asbestos Fibers From Dust

A battery of cyclone separators like the one pictured above separates asbestos fibers from contaminating dust in American Smelting & Refining Co.'s new $36-million mine and mill at Black Rock, Que. Fibers separate from host rock under repeated crushing; vacuum collectors suck up the liberated strands. Fibers are pneumatically conveyed to cyclones and are sorted into standard grades based on varying fiber length.

Ceramics Can Convert Heat Into Electricity

Westinghouse researchers have uncovered a class of thermoelectric ceramics that look promising as an economical means of converting heat directly to electricity on a limited scale without going through the conventional steam-generation cycle.

New ceramics are described as "mixed-valence compounds of the transition metals"; iron, nickel and manganese. Clarence Zener, Westinghouse's director of research, says that the new compounds operate with "promising efficiencies" at temperatures of 2,000-3,000 F.

Although thermoelectric compounds are far from new (thermocouples are an everyday example), the new ceramics exhibit the most promising economics. Metals have an inherently low conversion efficiency — around 1% — because they are good conductors. Semiconductors, like those used in transistors, have thermoelectric properties but these ultrapure materials are too expensive for economical heat conversion. New ceramic compounds, however, are claimed to be inexpensive, readily available and simple to prepare.

Zener points out that the new compounds, being ceramics, are stable and chemically inactive even at high temperatures. There are no restrictive purity requirements and high-vacuum or complex electronic apparatus isn't needed.

Zener cautions, however, that research on these materials is still in the early stages. He looks for ceramics to augment, rather than supplement, conventional power generating techniques; practical applications will probably appear where compactness, light weight and simplicity are more important than high efficiency.

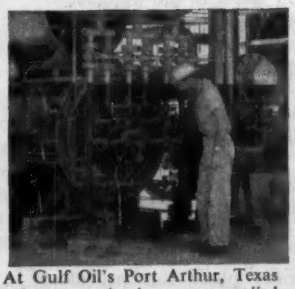
NEWS BRIEFS

High-temperature technique: Bell Telephone labs have developed a new technique for basic research in high-temperature reactions: High-intensity, high-speed flash lamp instantaneously induces heating of finely divided black-body particles or filaments in transparent materials—for example, black tungsten fibers in mineral oil, carbon or dust in polyethylene, powdered metals in vacuum or gas.

Aldehyde synthesis: Chemische Verwertungsgesellschaft, Oberhausen-Holten, has received a preliminary patent (DAS 1,034,167) for a process to make aldehydes from olefins. Process boasts almost total conversion in once-through operation. Reaction is carried out in vertical reactors, containing aqueous solution of cobalt-sulfate, iron-sulfate acid catalyst and overlaid raw aldehyde. Water gas plus olefins are fed in bottom of reactor. The two phases react at about 170 C. and over 200 atm. Ratio of two phases is preferably 1 to 1; aqueous phase must be renewed continuously.

For tested generator performance . . .

Come to Kemp



At Gulf Oil's Port Arthur, Texas refinery, purging inerts are supplied by Kemp Generator and Kemp Dryer working as a team. The units produce 30,000 SCFH for a bountiful and easily controlled supply at low cost.

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And Kemp design—rugged, simple, and sturdy—means that maintenance and attendance requirements are kept to a bare minimum. Kemp Inert Gas Generators stand up under the toughest conditions, yet produce with complete dependability.

To get detailed information and ideas, give your Kemp Representative a call. Or write us direct for Bulletin I-10. THE C. M. KEMP MFG. Co., 405 East Oliver St., Baltimore 2, Maryland.

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Atmos Generators

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Nitrogen Generators

Oriad Dryers

	Chemicals	Pulp & Paper	Petroleum Refining	Rubber	Stone, Clay & Glass	All Manufacturing
CAPITAL SPENDING						
Million Dollars						
1956	1,455	801	711	201	686	12,787
1957	1,724	811	853	200	572	13,647
1958	1,400	602	606	136	404	10,009
1959	1,288	566	588	163	447	9,678
1960	1,211	634	623	187	461	9,655
MODERNIZATION NEEDS						
% Installed Capacity						
Older than 8 yr.	53	66	71	55	66	67
SALES PROSPECTS						
% Increase, physical volume						
1958–59	10	7	4	11	11	9

CPI Spending Plans: Pursestrings still tighten, but aging equipment and brightening sales should reverse the trend.

Will Sagging Chemical Outlays Perk Up Soon?

William H. Chartener, McGraw-Hill Dept. of Economics

Chemical process industries (CPI) are still retreating—albeit more slowly—from the high-water mark in capital spending set in 1957. According to present preliminary plans, they will spend, as a group, about 3% less on new plants and equipment in 1959 than in the year just ending.

Capital spending in 1960 will be a little better for the process industries as a whole. But even then the level of spending will be about 25% below that of the peak year, 1957.

How soon capital outlays will again approach the 1957 level depends on how fast expanding sales can wipe out production overcapacity and how industry chooses to deal with the serious obsolescence of so much of its productive equipment.

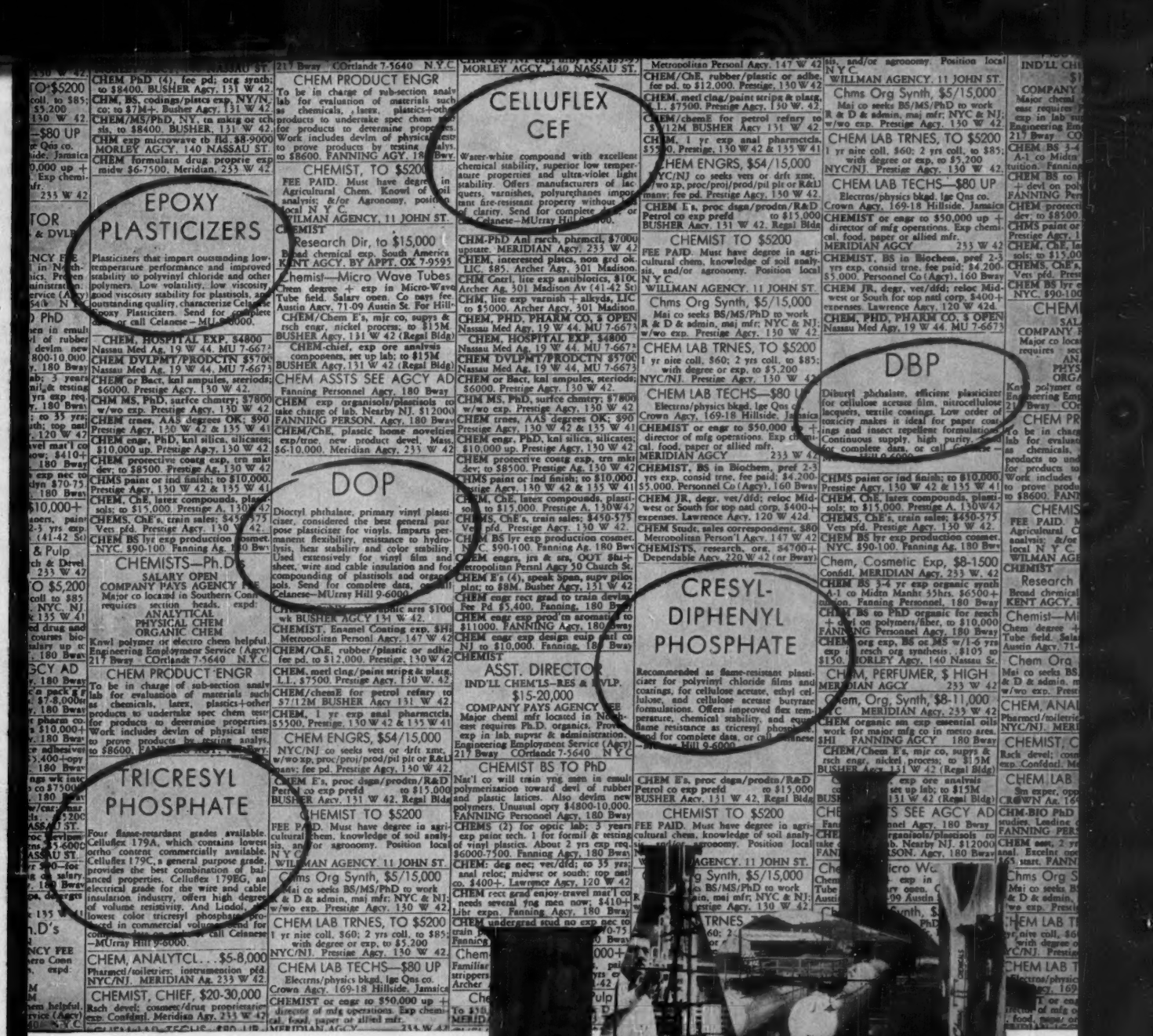
▶ **Stopping the Skid** — At any rate, the recent sharp decline in capital spending clearly has stopped—a decline which saw CPI outlays cut one fourth (about $1 billion) between 1957 and 1958. CPI companies as a group already plan to spend more in 1960 than in 1959. And every process industry, save chemicals, expects to spend more in 1960 than in 1958.

As a matter of fact, the 3% drop envisioned for next year is so small that there could well be a plus figure, instead, when final budgets are completed.

▶ **Chemical Cutback**—The chemical industry itself is the weakest area in the whole process-industry picture. It plans to cut capital spending by 8% next year and by another 6% in 1960. Even so, this industry will retain its number one spot among the manufacturing industries in spending on new plant and equipment.

These are just a few highlights from the McGraw-Hill Dept. of Economics' fall survey of preliminary plans for capital spending in 1959 and 1960.

The survey reflects thinking as of October. If the experience of other recoveries-from-recession is repeated, these preliminary plans will be stepped up in



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Aldehydes	Glycols	Salts	Aviation	Plastics
Anhydrides	Ketones	Solvents	Building	Surface Coatings
Esters	Oxides	Vinyl Monomers	Electrical	Textiles

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Capital Spending Jitters

	% Change '58–'59	% Change '59–'60
Cement	−16	+15
Drugs	+ 8	−15
Fertilizers	−33	+30
Rayon & acetate	−25	− 9
Soaps, fats, oils	−17	−16

later capital budget reviews.

Capital spending plans in individual process industries line up as follows:

Chemicals—Preliminary plans call for an 8% drop in 1959—to $1,288 million—after a slide of nearly 20% in 1958. Another dip of 6% is expected in 1960.*

Pulp and paper—Plans call for 6% less spending on new plants and equipment next year ($566 million), followed by a 12% hike in 1960.

Petroleum refining—Plans call for fairly level spending for the next two years: off 3% next year, up 6% in 1960.

Rubber—This industry plans the biggest percentage rise (20%) next year, after the biggest drop (20%) in 1958. Another 15% boost is expected in 1960. Dollar capital outlays for next year are figured at $163 million.

Stone, clay and glass—Companies expect to spend about $447 million next year, 11% more than this year. Another 3% increase is planned for 1960.

See the table on this page for capital spending plans for other sectors of the CPI.

▶ **More Than Enough** — Capital spending plans for the coming two years are strongly influenced by the amount of productive capacity now in place. Huge expansion programs over the past few years have left the CPI—and most other manufacturing industries—with adequate capacity to meet present needs.

An August survey by McGraw-Hill indicated total manufacturing capacity at the end of 1957 was about 50% higher than in 1950, only seven years earlier. (In chemicals, capacity has surged more than 75% in that same time.)

Meanwhile, production has not spurted nearly so fast. Even after the impressive recovery which started this spring, manufacturing industries as a whole were probably operating in September at less than 80% of capacity. So it would take a big boost in production to use up all the spare capacity industry now has.

▶ **Double Spark**—There are at least two solid reasons why industry's capital spending plans may be revised strongly upward rather soon:

- Increasing obsolescence — Despite all the new capacity installed since 1950, much of industry's present capacity is still out-of-date by today's standards and could profitably be replaced.
- Strengthening sales—Companies in all the process industries are looking forward to significantly higher sales in 1959.

What's more, they expect increases in physical volume of sales—not just increased dollar sales because of higher prices. Estimates range from a 12% sales increase, for companies supplying chemicals to the rayon and acetate industry, to a 4% increase, for producers of fertilizers and petroleum refiners. (See tables above and on p. 84.)

▶ **Old but Not Venerable**—In a recent modernization survey, McGraw-Hill's Economics Dept. learned that almost half (48%) of all manufacturing capacity (see chart p. 84) was installed before the end of 1945. Only a third is "modern" in the sense of being new since the Korean War began in 1950.

The chemical industry—with 47% of its capacity new since 1950—is better fixed than most manufacturing industries. But it still has a substantial amount of older plant and equipment that could profitably be replaced (*Chem. Eng.*, Nov. 3, 1958, pp. 113-130).

Cost of replacing obsolete chemical facilities with the best plant and equipment: $3 billion.

▶ **Accelerated Aging**—Does this mean that the chemical industry has less incentive to spend for capital equipment than most industries, in view of its considerable overcapacity and comparative modernness of that capacity? Probably not, since it can be safely said that chemical processing equipment ages more rapidly than most. A five-year-old chemical facility may be very inefficient in the light of this industry's particularly sharp company competition.

And the McGraw-Hill capital spending survey seems to indicate that all chemical processing industries are going ahead with this vast job of modernization at a time when expansion needs have diminished. Otherwise planned outlays for 1959 and 1960 would doubtless be much lower.

Indeed, modernization promises to provide strong underpinnings for capital spending until growth of consumer markets requires a new wave of expansion.

* In drawing its pursestrings still tighter, the chemical industry will be moving against the trend in most other manufacturing industries to spend more in response to the quickening pace of the economy on its way to recovery. Reason for continued chemical moderation: its remarkable spending spree of $4.2 billion in the last three years which culminated in the 1957 peak of $1.7 billion. For at the same time capacity was being swelled by 25%, sales were growing only 9%. Now a bit of a breathing spell seems to be in order.

Sales Confidence

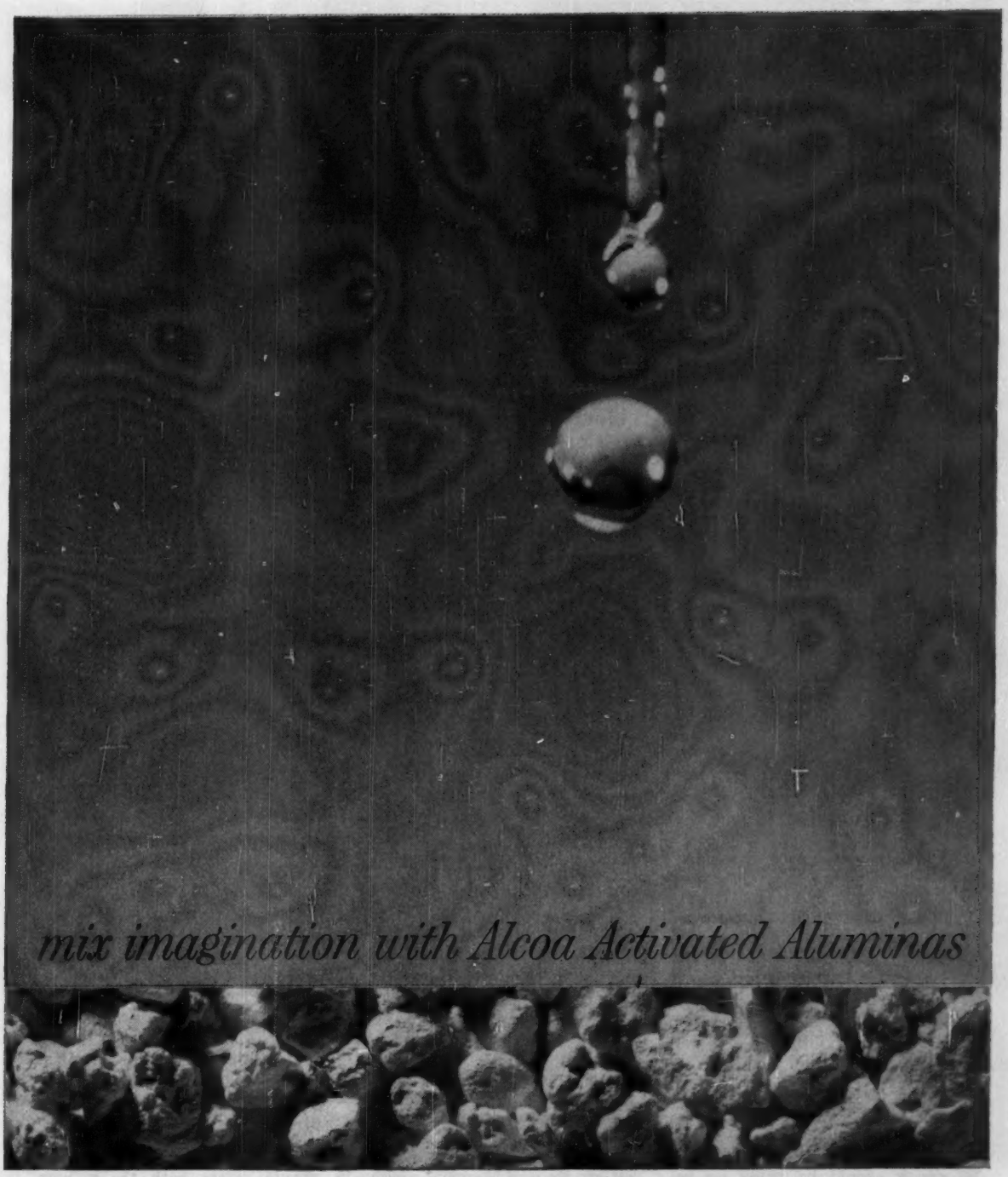
	% Increase, Physical Volume 1958–59
Cement	8
Drugs	5
Fertilizers	4
Rayon & acetate	12
Soaps, fats & oils	5

Sulfur Flood From North of the Border?

There'll be open season on sulfur markets when large-scale movement of Canadian natural gas to the U. S. becomes a reality soon.

Two major Canadian pipeline companies are seeking approval from Canada and the U. S. to jointly build and use a 105-mi. pipeline from southern Alberta to the British Columbia-U. S. border where it will be tied into our own distribution network for the Pacific Coast area.

If the plan goes through, the gas will begin to move, and western Canada's yearly output of sulfur from gas-stripping operations could soar to 1.5 million long tons.



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With an expected market of only 1.1 million tons in the offing, major sulfur suppliers in British Columbia and Alberta will have to scramble for outlets.

Here are the current byproduct-sulfur producers in the area, with their daily output in long tons: Jefferson Lake Petrochemicals at Taylor Flats, B. C., 400; Shell-Texas-Gulf at Okotoks, Alta., 350; Royalite at Turner Valley, Alta., 40; British American at Pincher Creek, Alta.; and Shell at Jumping Pond, Alta., 85.

As gas exports grow in volume, other sulfur production will come onstream in Alberta: Shell at Waterton, 1,500; Jefferson Lake at East Calgary, 700; and Jefferson Lake at Savanna Creek, 600.

Markets in northwestern U. S. and western Canada are figured to be able to absorb about 500,000 long tons yearly of this sulfur from natural gas. Overseas markets may shape up like this: New Zealand, 100,000 long tons; Philippines, Burma and Indonesia, 50,000; Australia, 200,000; India, 225,000; South Korea, 50,000; and an unknown amount in China.

Let's Pin a Dollar Sign On Industrial Research

Industrial research is wonderful—if it pays off. But how much money can be spent profitably on research and how do you get the most out of the funds allotted?

Case Institute's operations research group thinks the answer can be obtained mathematically and is out to prove it with the help of data supplied by four chemical companies.

During 1959 Case hopes to complete a manual which can be used by individual firms as an aid in determining how much money should be spent on research and development. This will involve, of course, the establishment of standards for individual research projects so that management can pick the best projects and decide when they should begin and end.

First, an analytic formula is needed, a formula which attempts to show how company progress is affected by money spent for R&D. To get data to construct the formula, Case is analyzing the four chemical companies—their financial performance and research expenditures—over a seven-year period.

Other necessary data: the effect on company profits of controllable and non-controllable variables. Non-controllable variables include general nationwide economic conditions, competitive conditions (pricing, advertising, product distribution), and internal conditions (company organization, productivity and market share).

Controllable variables include overall distribution of funds within main departments of the company, as well as specific breakdown of funds allotted for research and development.

A successful research formula would indicate more precisely to a company how it can meet adverse changes in variables beyond its control with adjustments of variables it can control.

Once Case has a R&D procedure for individual firms in hand, it will try to extend the principles to an entire industry, the chemical industry. Finally, the nation's economy will be the target as Case hopes to show how research money spent within an industry affects profits of other industries.

Europe's Common Market: Chemical Competition

Europe's Common Market plan will make life tougher for U. S. chemical producers heavily committed to overseas markets. Best advice may be: If you can't lick 'em, join 'em!

The countries involved are determined to make the economic integration work. Western Europe will be immeasurably stronger for it, better able to satisfy its own chemical requirements and to compete on a worldwide scale. U. S. chemical and allied products exports of $1.6 billion ($300 million to Common Market nations) will most certainly be adversely affected.

How can domestic chemical companies live with this growing, competitive, mass-market economy? The only solution, says General Aniline & Film's president, John Hildring, "is to accept, not fight it, and join it while there still is time."

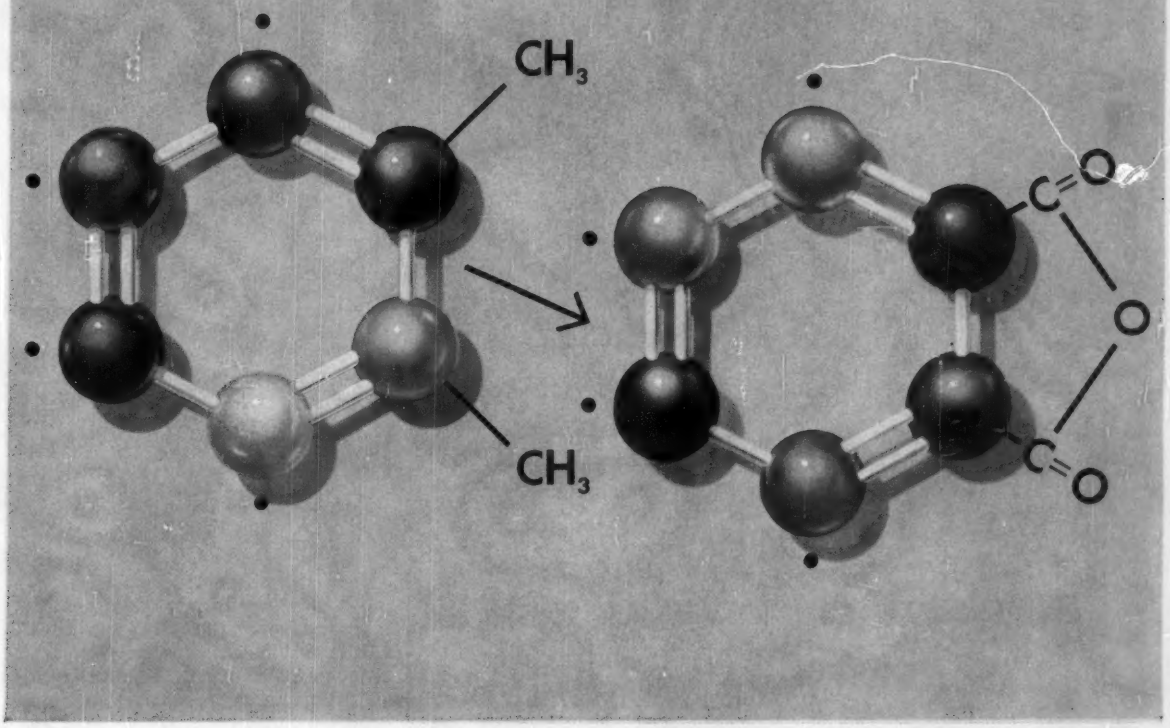
More easily said than done. For in the European Common Market scheme free enterprise will exist only when it does not stand in the way of the formation of a strong economic union. By the same token, cartel-like arrangements are a probability if they are in the best interest of all the member nations.

Tariffs will guard against imports from outside the Common Market area, while tariffs within will be eased to encourage trade between the member countries.

But there are ways for American industry to give a helping hand all around, to make some hay out of Europe's economic development. William J. Platt of Stanford Research Institute lists these opportunities:

- A growing consumer market after the U. S. pattern—Common Market progress should produce a single mass market of 170 million customers by 1970, a market very similar in size and character to the U. S. market today.
- A need for better distribution and marketing facilities—Europe's manufacturing technology is highly developed. But it could profit greatly from U. S. know-how in the realm of large-scale efficient distribution and merchandizing.
- Development of a specialized chemical industry—Chemical plants in Europe are much more vertically integrated than their American counterparts. Limited chemical markets within single countries haven't justified the manufacture of specialized intermediates (many chemical producers make their own raw materials). The resultant self-sufficiency means a very low degree of interindustry chemical sales. The Common Market effort should create both the volume and the cost competition to foster a specialty chemicals industry.
- Profitable exchange of technical know-how—This is already underway. As the need for U. S. know-how and funds increases in a developing European economy so should the harvest of return know-how increase for American firms.

ANOTHER
high purity Enjay Petrochemical...



ortho-XYLENE

This raw material for phthalic anhydride is the latest addition to Enjay's expanding list of petrochemicals.

For petrochemicals call on Enjay and be assured of a dependable supply of top quality products.

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Pioneer in Petrochemicals

FOR COMPLETE INFORMATION on specifications and characteristics of Enjay ortho-XYLENE and many other high quality petrochemicals, contact the nearest Enjay office. Shipments will be made from conveniently located distribution points in quantities to meet your development requirements.

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DEVELOPMENTS . . .

CHEMICAL PRODUCTS EDITED BY FRANCES ARNE

Fibrous Potassium Titanate Dead-Ends 2,000 F. Heat

A ¼-in. block of new fibrous potassium titanate protects hand of research chemist, Dr. K. L. Berry, from temperature exceeding 2,000 F.

The development of a process for converting potassium titanate into fibrous form may satisfy many space-age demands for light-weight insulation with high heat resistance.

Dr. Berry, one of the inventors of the product, is a member of Du Pont's Central Research Dept. Composed of small fibers which block heat penetration by scattering infrared rays, the still-experimental product is described by Du Pont as about twice as effective on a volume basis as any known insulating material in the 1,300 to 2,100 F. range.—Du Pont Co., Wilmington, Del. 90A

Substituted Phenol

New production of p-tert-butylphenol.

Now in production at the company's new plant in Millsdale, Ill., p-tert-butylphenol is one of a series of Stepan substituted phenols. It can be supplied flaked or concentrated solution in caustic. Bulk shipment of molten product can also be made where required.

Major use is in the coatings field, where the product is converted to phenol-formaldehyde resin. Its incorporation in varnishes is an aid to greatly improved resistance of the final film to water and alkali and it speeds drying time too.

Potential uses include utilization of its germicidal properties for protecting various products such as glues from bacterial attack, and as an effective antioxidant for many materials such as soaps and rubber.—**Stepan Chemical Co., Chicago, Ill. 90B**

Diuretic

High potency with minimal side effects.

It was reported at recent Southern Medical Assn. meetings that Esidrex™ (dihydrochlorothiazide) has been used successfully in relieving edema associated with high blood pressure, congestive heart failure and other diseases.

Average dosage required is much lower than that of other drugs of this type now in use because it is 5 to 10 times more potent than currently available diuretics. Laboratory studies indicate that this new diuretic also appears to have a longer duration of action and is a drug of low toxicity with minimal side effects. There has been some hesitancy to use other recently developed potent diuretics in patients under corticoid therapy because they may produce a further imbalance of certain essential body chemicals such as depletion of serum potassium. Researchers have found that Esidrex™ has little tendency to add these complications.

The new oral diuretic is not yet commercially available. Preliminary investigations by 150 clinicians here and abroad indicate that it is the most potent diuretic known today.—**Ciba Pharmaceutical Products Inc., Summit, N. J. 90C**

More REACTIVE

SOLVAY CAUSTIC POTASH

...produces MORE SOLUBLE END PRODUCTS!

Many users select caustic potash, rather than lower cost caustic soda, because it saponifies fats and grease more readily, and—most important—provides extra efficiency.

Since it is more reactive, the products made from it are also generally more reactive—more soluble, more effective. In fact, many powerful cleaners—including some of the popular heavy-duty liquid detergents—are based on products produced from caustic potash.

We invite you to make your own test of SOLVAY Caustic Potash. Available in two grades—Technical and Mercury Cell—dry forms and liquid, in steel drums and tank cars.

Sodium Nitrite • Potassium Carbonate • Caustic Soda • Chlorine
Calcium Chloride • Sodium Bicarbonate • Ammonium Choride
Caustic Potash • Chloroform • Vinyl Chloride • Methylene Chloride
Para-dichlorobenzene • Methyl Chloride • Cleaning Compounds
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Samples of Technical Grade Caustic Potash
☐ Flake ☐ Small Flake ☐ Solid
☐ Walnut ☐ Liquid, 45% strength
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☐ Flake ☐ Liquid

☐ Caustic Potash fact book

DR-12

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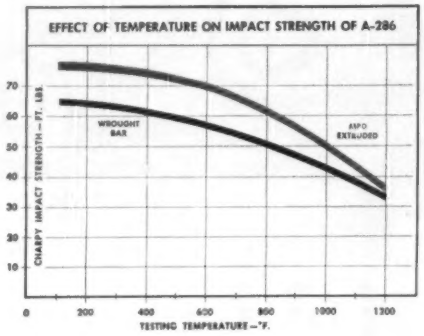
EXTRUSION • CASTING • FORGING • FABRICATION

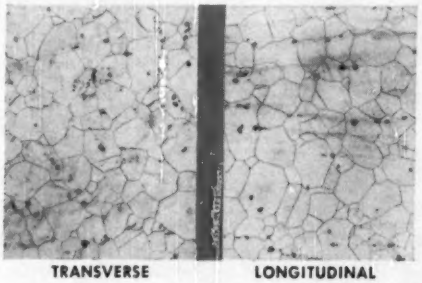
CURMET

Metals shaped under Micro Controls

From melt to finished product, steel and other premium alloys are under constant, critical surveillance at the Metals Processing Division of Curtiss-Wright Corporation. CURMET commercial products have the same built-in precision qualities that have steadily surpassed rigid military and commercial specifications for many years.



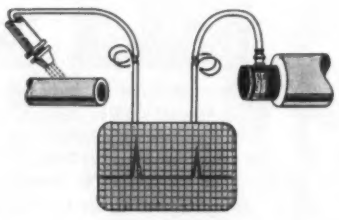
CURMET quality is more than inspection . . . though the most modern flaw detection methods are employed . . . it is the *in-process control of metal flow* that imparts premium properties and adds to service life.



TRANSVERSE LONGITUDINAL

CURMET processing with accurate metallurgical control is typified by this microphoto of a precipitation hardening, high temperature alloy extrusion (A-286) showing uniform longitudinal and transverse grains. Metallurgical examination of the extrusion shows uniformity of microstructure, assuring consistently high mechanical properties throughout the full length.

ULTRASONIC INSPECTION



IMMERSION TESTING — OR — CONTACTING TESTING

Permissible ultrasonic flaw indication for commercial products is 5% of wall thickness. Nuclear applications are specified at 3%. High-performance A-286 alloy, when CURMET processed, consistently passes ultrasonic testing at the 1½% level . . . with no defects noted even under these rigid test conditions.

CURMET ultrasonic testing can be applied to your forged or extruded product by either the immersion or contact method. Simple or complex, solid or hollow, your product gains quality by CURMET in-process control.

FOR FURTHER INFORMATION WRITE

METALS PROCESSING DIVISION
765 Northland Avenue

CURTISS-WRIGHT CORPORATION
Buffalo 15, New York

Latter Day "African Queen" Is Plastic

A fleet of three 15-ft. motorboats with hulls of polyester fibrous glass have just come triumphantly through a rough 3,300-mi. expedition through the inland waterway system of Africa. Conveyances for the first Trans-African Waterway Expedition, engaged in charting a route to serve as the "St. Lawrence Seaway of Africa," the boats have reinforced plywood hulls. Fibrous glass hull skins were made with polyester resins supplied by Poly-Resin Products, Ltd., a Reichhold affiliate. — Reichhold Chemicals, Inc., White Plains, N. Y. 93A

Trimellitic Anhydride

Offers special benefits for alkyds, unsaturated polyesters, inks.

Trimellitic anhydride is now available in development quantities. This product is the first in a series of new aromatic acids developed by Amoco as a result of the new Scientific Design-Standard-Amoco oxidation process.

It offers high reactivity, trifunctionality, and an acid-anhydride combination. These characteristics should provide special advantages in preparing alkyd resins — including a water-soluble variety (*Chem. Eng.*, Nov. 17, 1958, p. 60), unsaturated polyesters, printing inks, resin intermediates, adhesives, molding resins, dyes and many other materials.

Amoco's excellent raw material supply and novel oxidation will permit commercial production at an estimated selling price of 25-35¢/lb. Developmental quantities are selling for $3/lb.

Not a byproduct or coproduct of the plant to produce isophthalic, phthalic and terephthalic via the new oxidation process, which Amoco will put on stream late this year in Joliet, Ill., trimellitic anhydride will require facilities of its own.

It is produced by oxidizing trialkyl benzenes. The acid is subsequently dehydrated to form the anhydride. The company will be making a decision regarding the new plant within six months, hopes to have construction started within 18 months.

Trimellitic anhydride can hydrolyze to the acid, triesterify with alcohols, form salts and amides, condense with aromatics in Friedel-Crafts syntheses, etc.

Its novel structure enables the chemist to specifically react the anhydride group and still retain two carboxyl groups for further reactions. Interesting new resins can be formed by initially reacting trimellitic anhydride with an alcohol to form the monoester. Condensation polymers can then be formed by further esterification with glycols.

A wide variety of polymers with unique properties can be prepared by employing different alcohols and glycols.—**Amoco Chemicals Corp., Chicago. 93B**

BRIEFS

Adhesive 910, Eastman's polymethyl-2-cyano-acrylate which has been described as the perfect industrial adhesive, has been turned over to Armstrong Cork's industrial division for marketing. Distinguished by fast set and strong bond, 910 should have broad industrial use but because of $75/lb. price, volume will be small. Eastman retains responsibility for chemical industry distribution.— **Eastman Chemical Products, Inc., New York, N. Y. 93C**

New high-density polyethylene film, based on Super Dylan Type 606F, has good clarity and gloss and enough stiffness to handle well in packaging equipment. — **Kopper Co., Pittsburgh, Pa. 93D**

Developmental filament yarn, called 957 but soon to be announced under a regular trademark, shows commercial potential as an unusually durable wall covering which can be applied conventionally. — **Dow Chemical Co., Midland, Mich. 93E**

Nitro-paraffins are being investigated as a promising substitute for motor fuel which could double the power output of auto and aircraft engines.—**University of California, Berkeley, Calif. 93F**

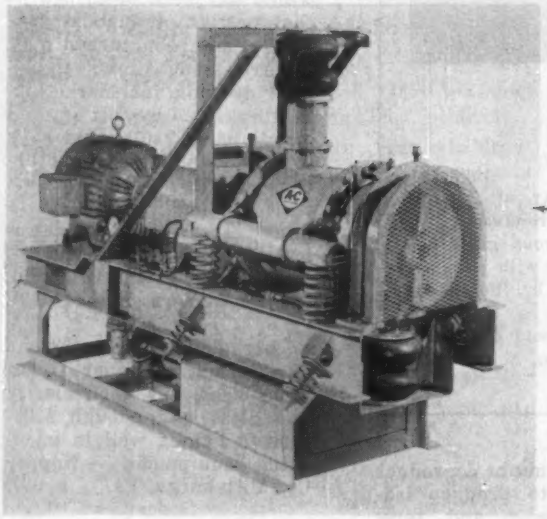
For More Information . . .

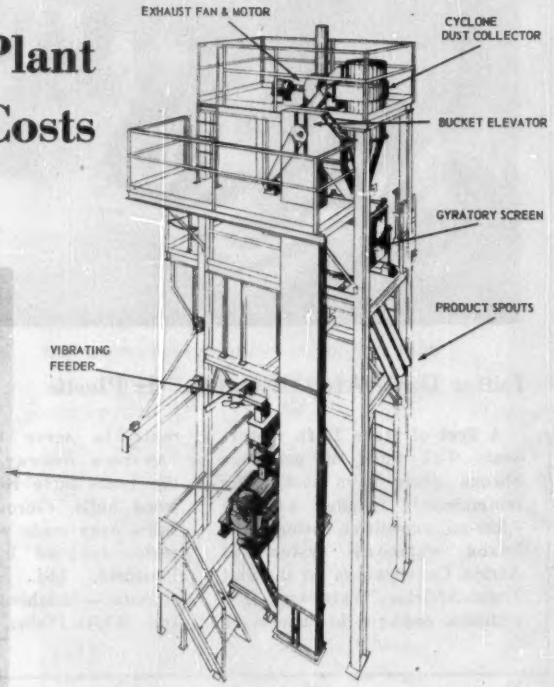
about any item in this department, circle its code number on the

Reader Service

postcard (p. 237)

Packaged Grinding Plant Jolts High Costs





Designed around a novel vibrating ball mill, a new pre-engineered grinding system features low initial cost, energy consumption and floor-space needs.

FOR THE general public, the do-it-yourself influence is in full swing. Consumer-durables manufacturers are delivering raw and semifinished products that scarcely resemble their ultimate, useful forms.

For the process industries, the trend appears to be in the other direction. More and more equipment manufacturers are turning out packaged plants—integrated assemblies of machines that remove the process-design, equipment-selection and installation burdens from the customer's shoulders.

One of the most recent additions to the growing list of packaged processing assemblages is Allis-Chalmers' pre-engineered grinding plant.

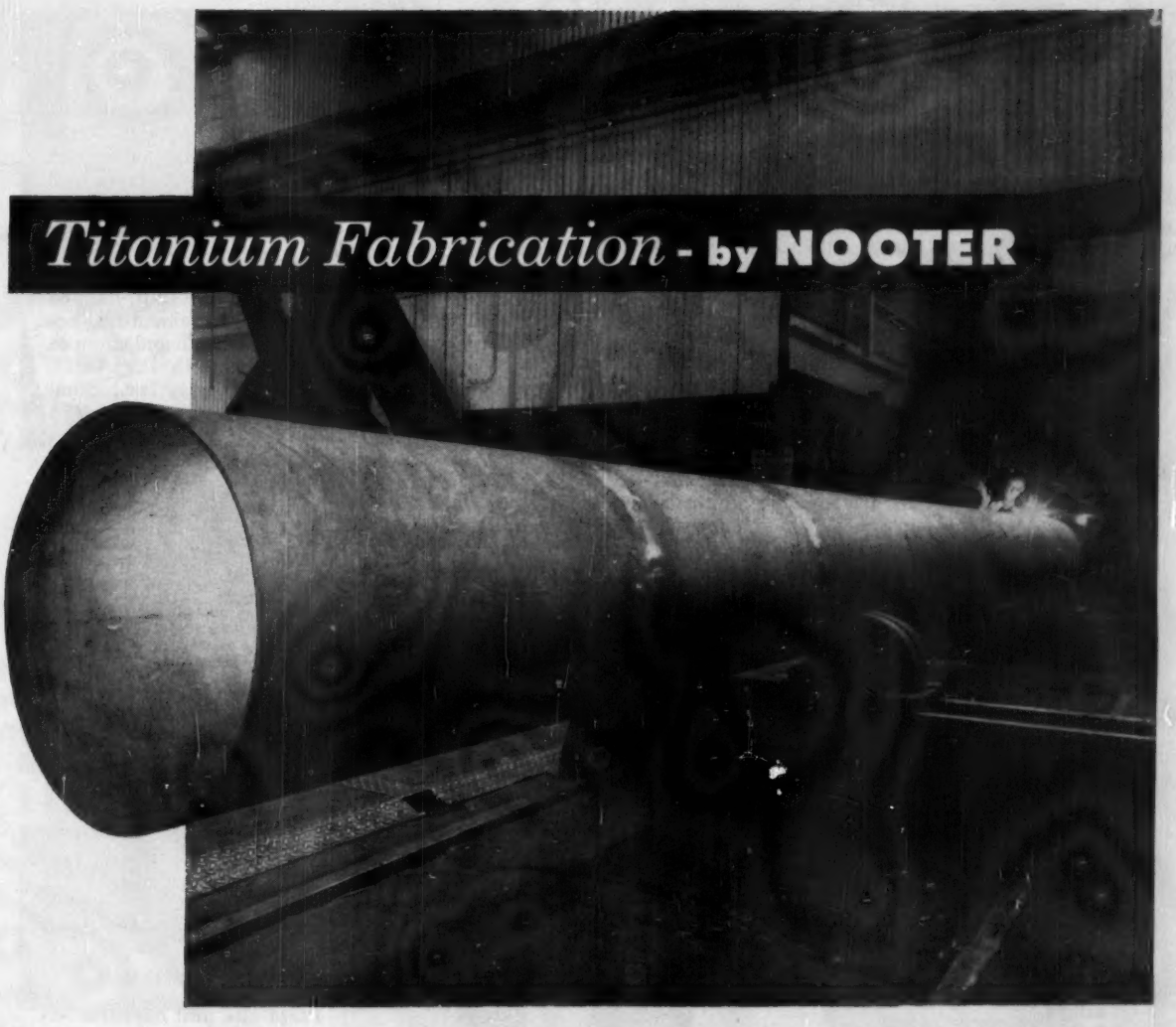
▶ **Look at What You Get**—Here are some of the plant's specifications. Input: Cement clinker, shale, phosphate ore, paint pulp or almost any other dry material with a density between 30 and 300 lb./cu. ft. Output: Up to 1 ton/hr. of product having a finely controlled particle size. Grinding-energy expenditure: 15 hp. Floor space: 127 sq. ft.

A-C's new package is centered around a newly designed vibrating mill. Compared with conventional tumbling mills, this versatile machine is claimed to provide up to 30 times more capacity per cu. ft. of grinding volume.

For example, the 15 × 15-in. vibrating mill now furnished with the packaged plant has a grinding capacity comparable with a 4 × 8-ft. conventional rotating ball mill. Another of the new mill's features—variability of vibration speed and amplitude—permits wide changes in both type and size of feed input or product output.

Auxiliary A-C equipment included in the package consists of a vibratory feeder, elevator, gyratory screen, weighing device and dust collector.

▶ **Package Cost Is Low**—Initial cost of Allis-Chalmers' mill is



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Nooter can and is now welding any type of zirconium, tantalum, or titanium plate fabrication . . . with single or multiple pass welding, fully X-rayed. In titanium work, the metal can be either commercially pure, or in some alloyed forms.

The welding and fabrication of these new metals is a pioneering task, exacting the highest skill and ingenuity from those who would unlock and put to use their special capabilities. It is not a new role for Nooter, with more than a half-century of experience as a custom fabricator. Through continuous, painstaking and imaginative metallurgical, fabricating, and welding research, Nooter over the years has led the way in developing techniques for working and welding many new metals and alloys.

And now...the RARER METALS! When they fit your needs, let Nooter put them to work for you.

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said to be at least one-third less than that of any other machine of like capacity. And, with less than 1½ cu. ft. of available grinding volume, the mill obviously affords considerable economy in grinding media (balls or rods).

These two characteristics account, in part, for the packaged plant's low cost. According to the manufacturer, the over-all price tag show a 25% savings in initial cost compared to other grinding facilities of similar capabilities.

▶**Mill Installed, Plant Soon**—As yet, none of the packaged plant assemblies have been put into full-scale commercial operation. However, installations consisting of the vibrating mill in circuit with customer-selected combinations of auxiliary equipment seem to forecast an eventual wide scope of application for the package. Here's a partial list of existing mill applications:

- A minerals company uses the mill to grind barite.
- Fired silica refractory is the feed to another noteworthy installation.
- An alloys producer is using the mill to grind zirconium oxide.
- Another firm applys the mill to size reduction of ferro alloys.

▶**Construction and Operation**—Feed stock from a 100-cu. ft. storage bin drops into a vibratory feeder that controls charging rate to the vibrating mill. En route to the mill, the feed passes over a bypass chute that permits periodic materials take-off for weighing.

Basically, the mill is a spring-mounted horizontal cylinder with an enclosed eccentric mechanism running along its axis. Grinding balls (or rods) occupy about 80% of mill volume. All wearing parts are replaceable.

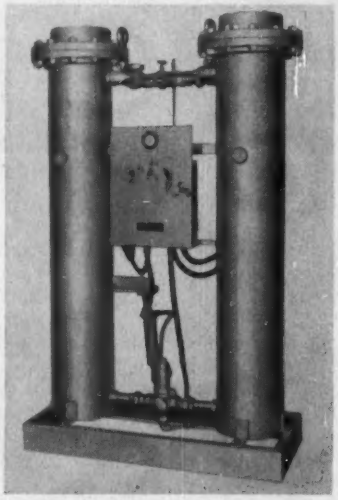
In operation, vigorous high-speed vibration of the grinding chamber causes the balls to strike each other as well as the walls of the chamber and the protective enclosure surrounding the eccentric shaft. In the course of size reduction, the charge swells to fill all available chamber volume.

Discharge from the mill travels via bucket elevator to a gyratory sizing screen. Three product spouts deliver specified size fractions. Oversize material recirculates to feed bin.

A 1,200-cfm. fan, pulling through a cyclone separator, aspirates the feed bin, feeder, mill discharge chute and elevator to maintain dust-free operation.

▶**Installation Information**—As furnished, Allis-Chalmers' four-level packaged grinding plant is only 11 ft. 6 in. long, 11 ft. wide and 28 ft. high. Ladders and catwalks amidst the plant's superstructure make all components readily accessible to operating and maintenance personnel. Customers must provide a suitable indoor or outdoor concrete pad for mounting.

The entire structure comes with one coat of primer paint and one coat of finish paint.—**Allis-Chalmers Mfg. Co., Milwaukee, Wis.** **94A**

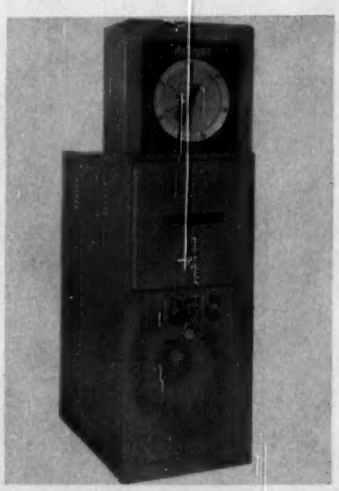


Gas Dehydrators

Packaged equipment drops dewpoint of gases.

A new line of solid-adsorbent packaged plants for dehydrating compressed air and gases is claimed to be capable of producing dewpoints below −100 F. continuously and automatically. Known as Dehydritrols, the new units utilize a pair of alternating chambers containing special desiccants to eliminate moisture from instrument air, process feed gases or finished gaseous products. Type of desiccant varies with application.

All inner parts are readily accessible through full-flanged ports. Desiccant chambers are designed, fabricated and stamped in accordance with the ASME code.—**Gas Drying, Inc., Summit, N. J.** **96A**



End-Point Apparatus

Plant-site unit operates automatically.

Pour a hydrocarbon sample into the apparatus. Push a button. Wait 20 min., and then read the sample's recorded end point from a chart.

According to the manufacturer, this new automatic end-point recorder determines the maximum temperature attained during distillation tests without laboratory help, and right at the site of refining operations.

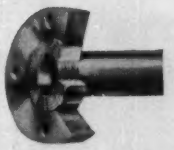
Operating range is 225 to 675 F. Reproducibility is ±2%. Safe for Class I Group D hazardous locations (except for recorder, which can be remotely located), the apparatus requires a minimum of maintenance and calibration. — **Precision Scientific Development Co., Chicago, Ill.** **96B**

Pneumatic Conveyor and other equipment news on page 208.

3 BIG REASONS WHY...

1. FLANGE WITHOUT WELDING

Faster than welding... *easier* than welding. A Speedline Insert Flange assures a leak-proof, *expanded* joint *every* time. Saves assembly time *and* costs!



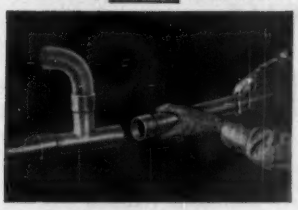
Cutaway view shows pipe expanded into insert Flange

2. LEAKPROOF UNION JOINTS

Speedline Unions are *gasket seated* to prevent leakage ... bi-metallic for easy make-up and disassembly without galling or seizing. Available in two types: PE for expanding or PW for welding to Sch. 5 or 10 pipe and Speedline Fittings.

Type PW—For Welding

3. EASIER, FASTER ALIGNMENT



Speedline Aligning Connectors fit *over pipe ends* ... save time in aligning the most complex layout —permit preassembly *prior* to welding or brazing!

***PLUS* SPEEDLINE'S "EXTRA LENGTH" FEATURE**—There's an extra straight section on *every* end of *every* Speedline elbow, tee, reducer, bend and cross. This means extra clearance for welding and also facilitates joining with flanges or unions. Speedline Fittings, designed especially for use with Schedule 5 and 10 light wall stainless pipe, offer installation advantages and other cost savings not possible with conventional fittings. Write today for Speedline catalog or contact nearest Distributor.

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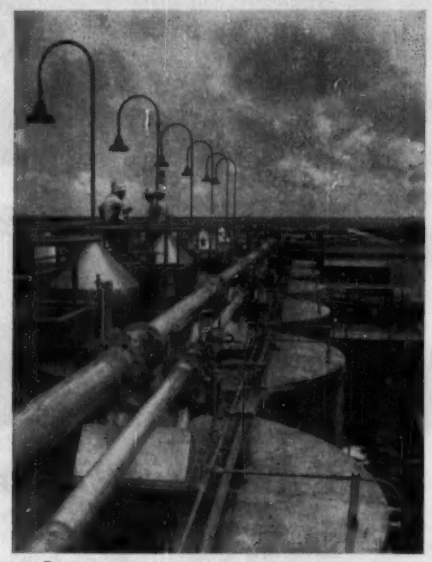
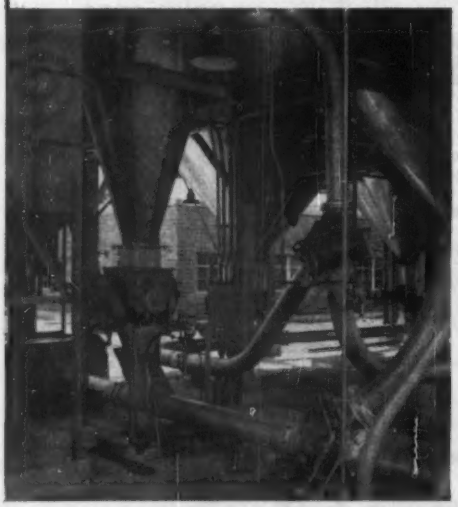
Canada

1. Installation at an ultra-modern plant of one of the largest companies in the chemical field. Shown are storage bins with airtight automatically operated discharge gates.

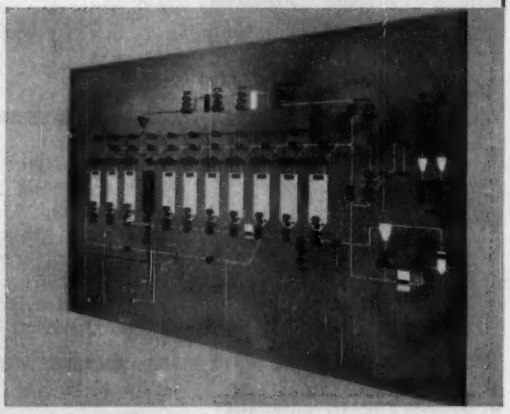


3. Series of bins served by pneumatic conveyor systems with diverter valves.



2. Transfer station, handling polyethylene pellets at rates of 60,000 lbs. per hour, receives materials delivered from any one of several points under vacuum; transfers them to the pressure side of the system for delivery to any one of several discharge points.

4. Graphic control panel built for explosion-proof service. Permits operator to direct flow of materials through proper channels from one central location.



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If your plant handles fine dry materials in quantity, let National survey your needs and submit a prompt proposal. Chas. Pfizer & Co., Inc., U. S. Rubber Co., U. S. Steel Corp., and many other leading companies have made National their choice. National is equipped to design, build and install your complete pneumatic conveyor system ... or an addition to your present one. Our testing laboratory is available to determine precise handling requirements for your materials. All this can be done under one contract and one responsibility by a company that can move quickly. Many of the nation's largest chemical companies have returned to National for repeat installations ... sure testimony to their satisfaction with National's performance. Consult National now ... write us or our nearest representative listed below.

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For additional information, consult Chemical Engineering Catalog and Sweet's Catalog

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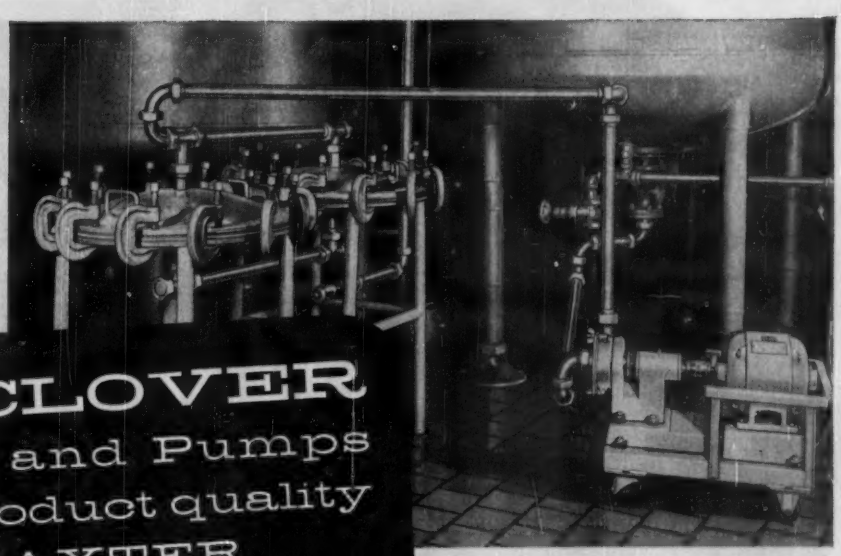
Also manufacturers of: **National ChipVeyor Systems** for the collection and processing of metal chips and borings and reclamation of cutting oils (send for Bulletin C-56). **Conveyors** for press scrap and small parts. **National Ash Conveyor Systems** for handling ash and fly ash (send for Bulletin P-57A).

REPRESENTATIVES

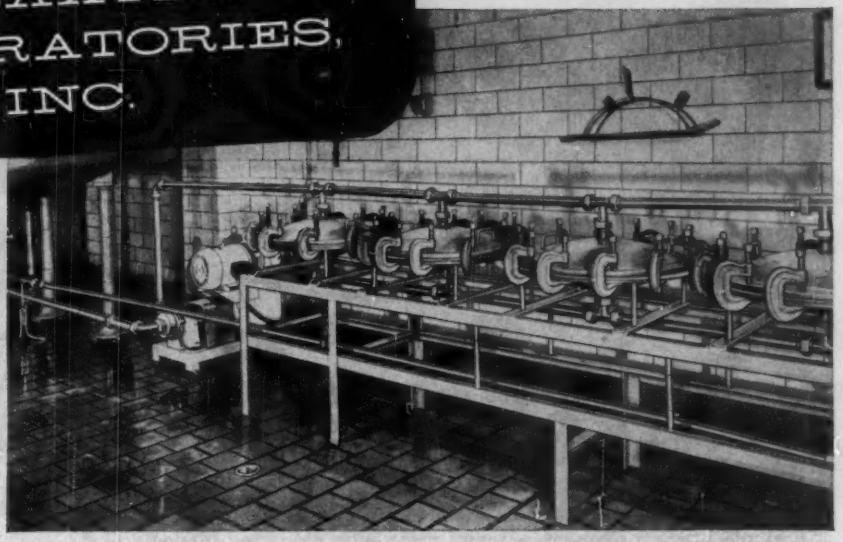
ATLANTA 3, Ga. — P. H. Nichols & Co. — 400 Whitehead Bldg. • **BALTIMORE 18, Md.** — Lamb Engineering Co. — 2125 Maryland Ave. • **BOSTON 94, Mass.** — Mills Engineering Co., Inc. — 300 First Ave., Needham Hts. • **BUFFALO 2, N. Y.** — Charles P. Hague, Inc. — 625 Delaware Ave., Rm. 202 • **CHARLOTTE 7, N. C.** — E. L. Mountcastle — 2617 Selwyn Ave. • **CHICAGO 4, Ill.** — Burke & Colston (Ash) — 53 W. Jackson Blvd. • **CHICAGO 5, Ill.** — Mayer & Oswald (Chip) — 407 S. Dearborn St. • **CINCINNATI 27, Ohio** — Smith E. Hughes — 3716 Petoskey Ave. • **CLEVELAND (Lakewood 7), Ohio** — J. Harry Haywood — 12031 Edgewater Drive • **HARTFORD, Conn.** — Dee Engineering Co. — Cromwell, Conn. • **HOUSTON 5, Texas** — Industrial Handling Engineers — 1200 Bissonnet • **LOS ANGELES 13, Calif.** — W. F. Huff and Co. — 417 South Hill St. • **PHILADELPHIA, Pa.** — C. V. McQuarry — P.O. Box 52, Cheltenham, Pa. • **PITTSBURGH 29, Pa.** — Gibson & Stanier Engineered Products — P.O. Box 9742 • **ST. LOUIS 22, Mo.** — Medor, Inc. — 10408 Manchester Ave.

View showing some of the Tri-Clover fittings and one of the transfer pumps being used in the main processing room at Baxter Laboratories.



TRI-CLOVER
Fittings and Pumps guard product quality at BAXTER LABORATORIES, INC.

Here is a partial view of the thorough pressure filtration applied to intravenous solutions prior to bottling, in which Tri-Clover fittings and pumps play an important part.



Baxter Laboratories, Inc., has established an enviable reputation in the ethical drug field as the pioneer producers of intravenous solutions to serve the requirements of modern medicine.

Baxter, in its manufacture of medical products, *must* safeguard against all forms of contamination . . . particularly in the preparation of intravenous solutions for infusion into the blood stream.

It is highly significant that Baxter utilizes numerous Tri-Clover Division stainless steel fittings, together with Tri-Clover centrifugal pumps, in their various processing operations, to insure highest standards of product purity and processing efficiency.

For at Baxter Laboratories, as in other important processing operations, users have found that there is no substitute for the high quality and complete sanitation inherent in Tri-Clover products.

Why not let Tri-Clover corrosion-resistant fittings and pumps help to achieve new standards of efficiency and sanitation in *your* processing operations? Our engineering staff will be glad to work with you in helping to solve your specific corrosion-resistant piping and pumping problems.

See your nearest TRI-CLOVER DISTRIBUTOR

1-158

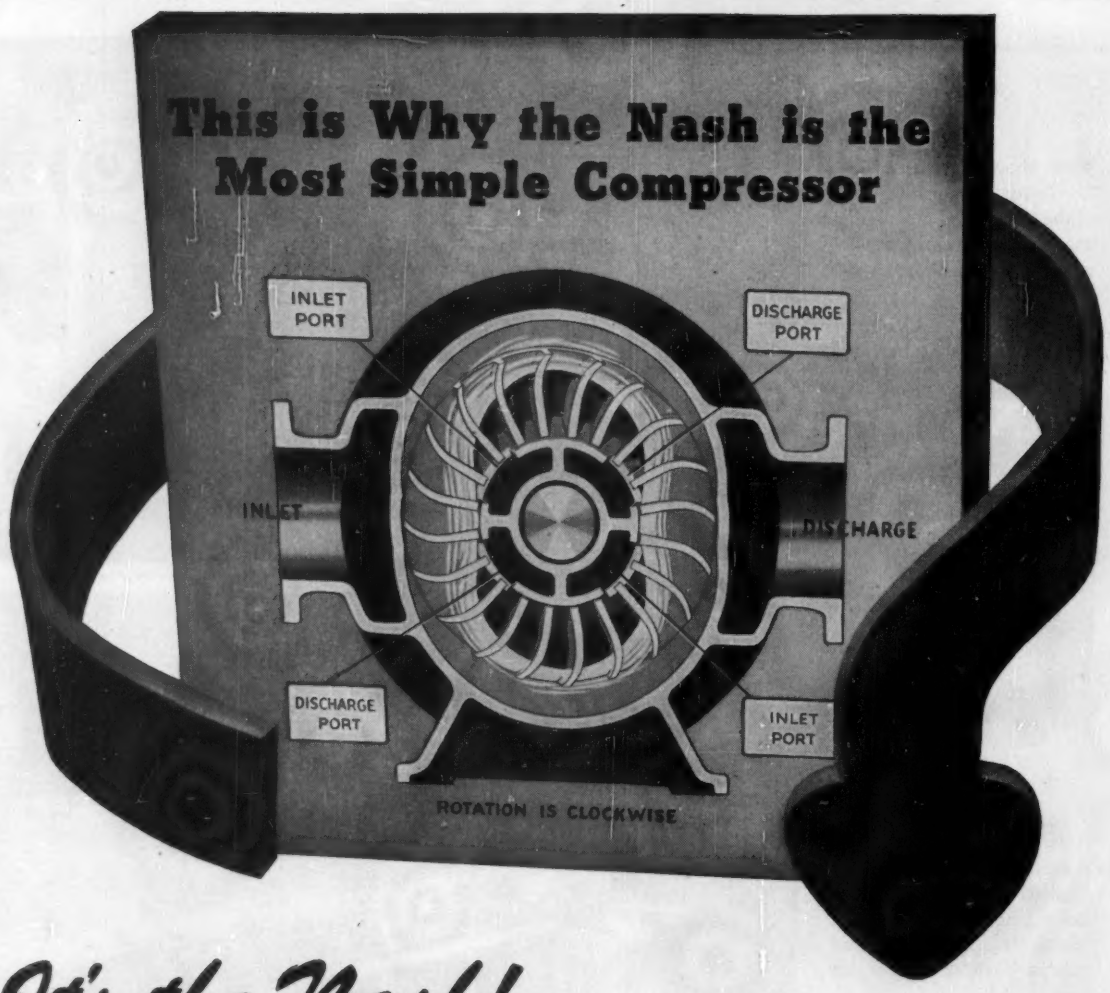
TRI-CLOVER

LADISH CO.

Tri-Clover Division

Kenosha Wisconsin

IN CANADA: Brantford, Ontario
EXPORT DEPT: 8 South Michigan Ave., Chicago 3, U.S.A. Cable "TRICLO" Chicago



It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods Data on these pumps sent immediately on request

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

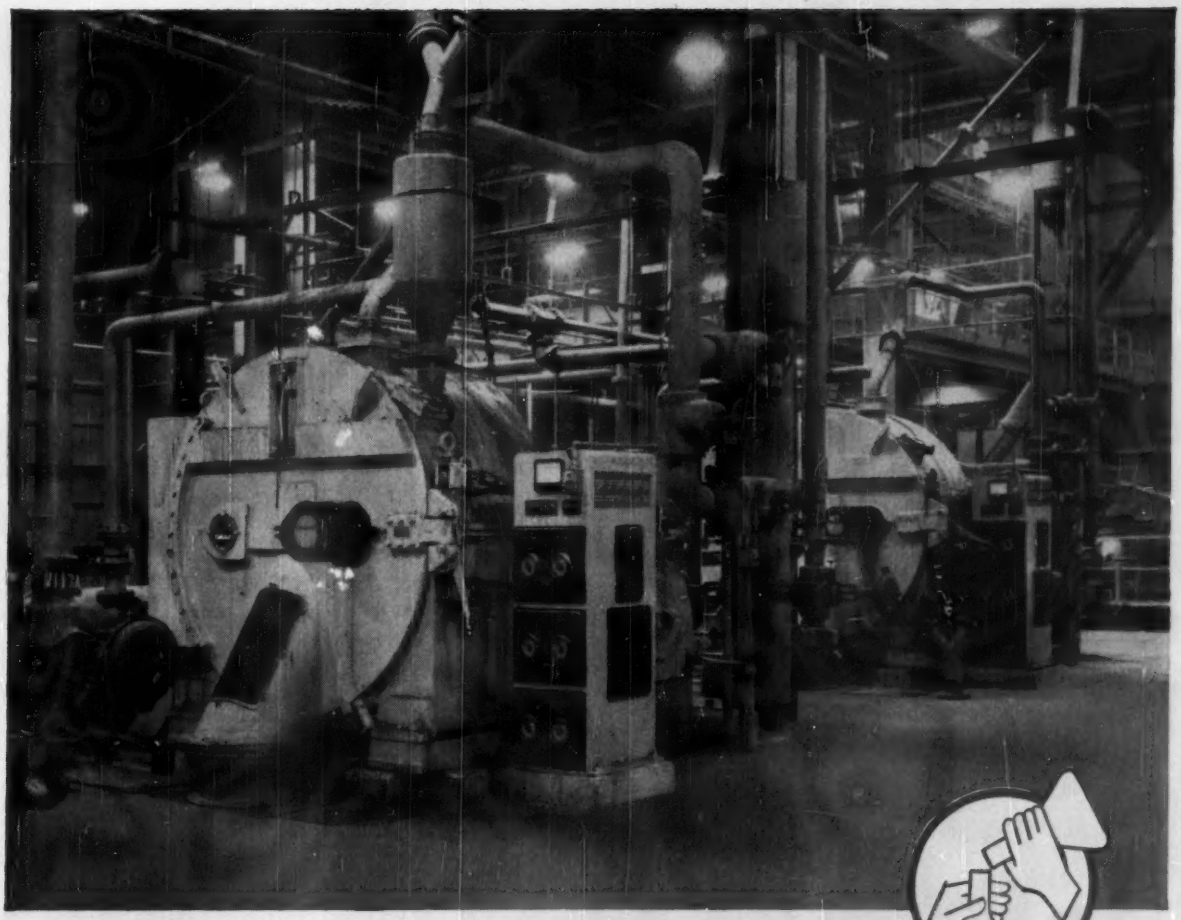
Saves floor space.

Desired delivery temperature automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY
313 WILSON, SO. NORWALK, CONN.



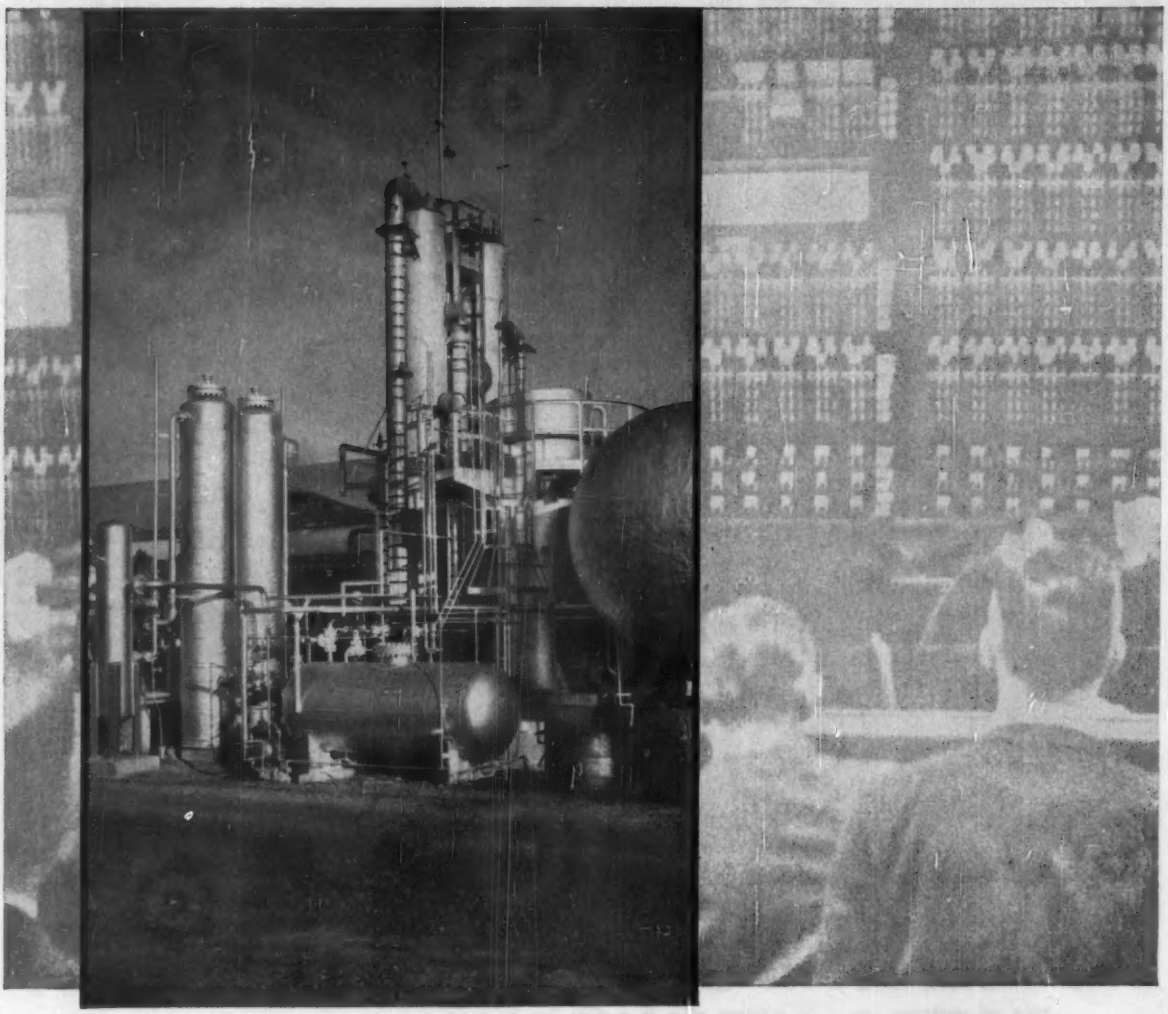
B-P CENTRIFUGALS used by ELECTRO METALLURGICAL COMPANY in Titanium Production

Although a metal, titanium is produced by a chemical process. Metal in the form of ore is converted to titanium tetrachloride, which is purified and then reduced to metallic sponge by sodium. In order to separate the brine from the titanium sponge, Electro Metallurgical Company, Division of Union Carbide Corporation, New York, utilizes Baker Perkins 66" diameter type HS Universal Centrifugals. It's a tough application, but the B-P Type HS has proven itself efficient and dependable. These same machines are adaptable to a wide range of filterable fine solid-liquid slurries. Baker Perkins also manufactures type S Continuous Centrifugals which are used extensively for the separation of filterable coarse solid-liquid slurries.

Since centrifugation is such an important process in the chemical industry, and, since there are so many types of slurries that must be separated, Baker Perkins engineers give special design consideration to each specific problem. No matter what factors are involved in each application, our engineers can make recommendations on the proper centrifugal machinery.

Send for your copy of Catalog CE-58 for complete information on size, type and capacities of Baker Perkins "Tor Moer" Centrifugals.

BAKER PERKINS INC. CHEMICAL MACHINERY DIVISION SAGINAW, MICHIGAN



Turns waste gas into dry ice... through Pritchard's GOOD FINANCIAL DESIGN

How to make dry ice economically from impure waste CO_2 gas. That was the crux of the problem in the design and construction of Allied Chemical's dry ice plant at Hopewell, Va.

J. F. Pritchard & Co., engineers and contractors for the plant, not only found the answer but devised a unique process (now patented) that enabled Allied to strip out the contaminating elements—hydrogen and nitrogen—and use them to produce ammonia. Allied completely utilizes its raw gas and turns what looked like a waste material into marketable commodities.

This is another example of Pritchard's good financial design in action in the chemical industry. But good financial design is more than creative engineering alone, more than astute planning and purchasing, more than cost-conscious construction. It's the combination of these factors in such a way that a Pritchard-built plant makes maximum return per dollar invested.

Pritchard's broad experience in building chemical facilities and sound business approach to technical construction are at your service—to help you build for greater profits. We'll be glad to send you details of our complete engineering and construction service for the chemical industry.

PROFITABLE FACILITIES THROUGH GOOD FINANCIAL DESIGN

J.F. Pritchard & Co.

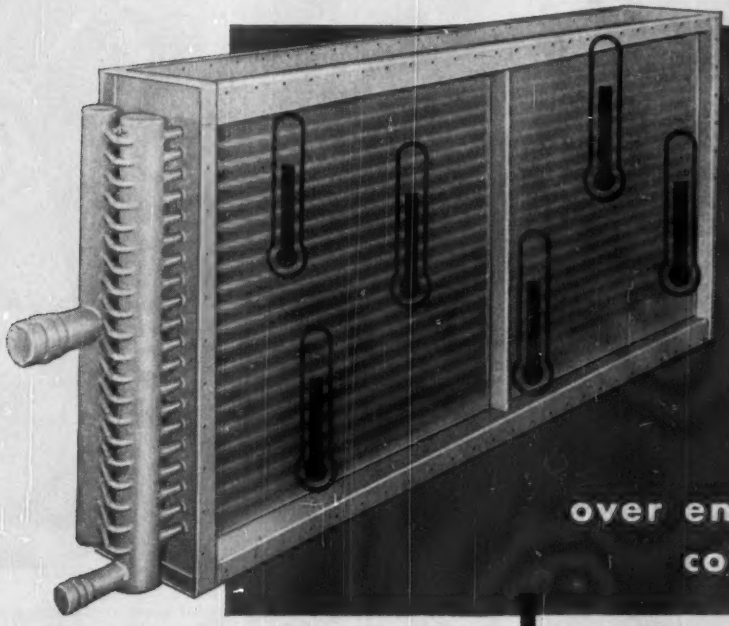
ENGINEERS • CONSTRUCTORS

Dept. 404, 4825 Roanoke Parkway, Kansas City 12, Mo.

OFFICES IN CHICAGO, HOUSTON, PITTSBURGH, NEW YORK

SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES

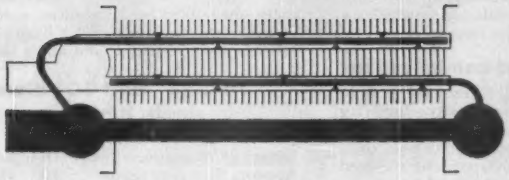
UNUSUAL NEW TYPE OF STEAM COIL DESIGNED TO PROVIDE



UNIFORM SURFACE TEMPERATURES

PRECISE TEMPERATURE CONTROL

over entire coil face area!



Marlo EVNTEMP

DISTRIBUTING STEAM COIL

Available in Corrosion Resistant STAINLESS STEEL

Here's a completely new approach to steam coil design and engineering—with no extra cost. The unique construction of the Evntemp provides uniform temperatures over the entire coil face area, throughout the whole operating range, even under extreme temperature modulation, and even in coils up to 10 feet long. Response to temperature control adjustment is almost instantaneous.

Steam supply and condensate connections are on same end; coils are pitched in casing for easy installation.

Evntemp coils can be designed for any temperature and pressure. A typical specification: tubes and headers of Type 304L seamless tubing, frames and fins of Type 304 stainless steel, all welding with special stainless steel alloys to prevent carbide precipitation.

Send coupon for new Bulletin M-10 on this unusual new steam coil.

Marlo coil co.

SAINT LOUIS 11, MISSOURI

Quality Air Conditioning and Heat Transfer Equipment since 1925

MARLO COIL CO.
7118 South Grand

☐ I am also interested in stainless steel applications.

Name_____

Company_____

Address_____

City_____ Zone____ State_____

"Package" ion exchange equipment for lab or pilot plant . . . from stock

Laboratory ion exchange column

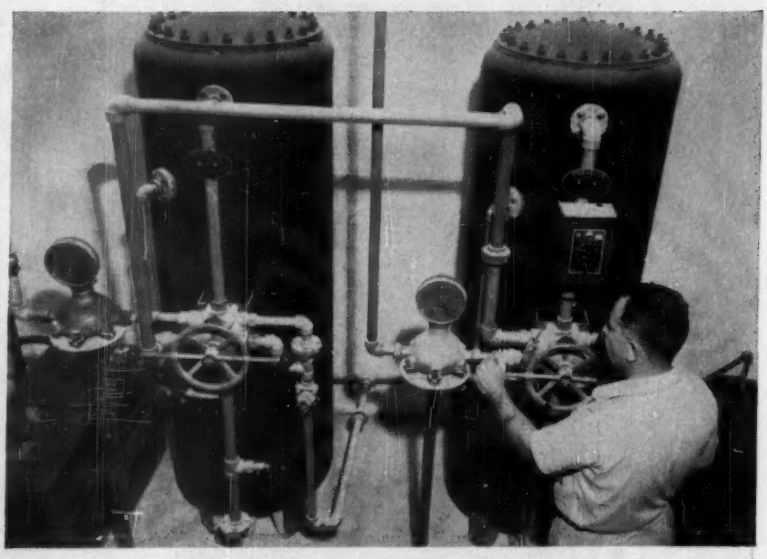
The Permutit laboratory or lecture-table kit includes a 1½" O.D. glass tube with one end drawn down to fit ordinary laboratory rubber tubing, the ion exchange resin or resins required and literature describing ion exchange experiments. The user supplies the

stand, clamps, tubing, stoppers and beakers. The tube will hold sufficient Permutit Q ion exchange resin to remove 20 to 25 grains of hardness.

This simple set-up is used for demonstrating ion exchange processes such as softening, dealkalizing or demineralizing water and for experiments in removal of impurities from process solutions and separation of metals from leached ores or waste liquids.

MBD-6A mixed bed demineralizer

The MBD-6A unit (6" diam.) contains a mixture of Permutit Q cation exchange resin and Permutit S anion exchange resin. It will demineralize 1 to 2 gpm of water to a low total solids, low CO_2 and low silica content. Refills containing pre-mixed resin are available. Each refill has a capacity of approx. 1500 grains total electrolytes as $CaCO_3$. When the unit is exhausted, the fill may be discarded or regenerated and re-used.



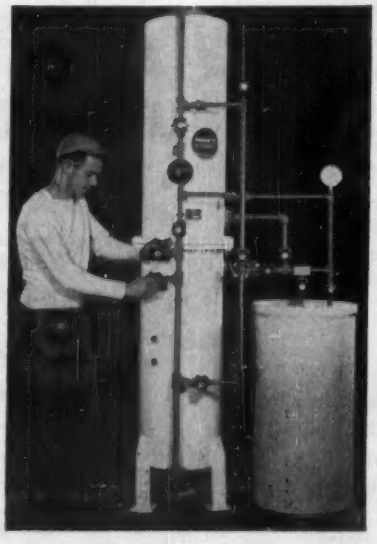
A conductivity cell is mounted in the outlet line to be used with a conductivity meter for measuring the electrolyte content of the effluent and thus indicating when the resin bed is exhausted.

Standard equipment includes the MBD-6A with initial fill, faucet adapter and hose and conductivity cell. Optional equipment: conductivity meter, resin refills and an auxiliary tube for regenerating the resins.

MBD-15 mixed bed demineralizer

This compact unit will demineralize 6 to 7½ gpm of water to an average conductivity of 0.15 micromhos (approx. 6,000,000 ohms specific resistance per cm or 0.05 ppm total electrolyte content). CO_2 will be reduced to 0.1 ppm and SiO_2 to about 0.1 ppm.

Capacity of the MBD-15 between regenerations is approx. 20,000 grains total electrolytes. For example, it will demineralize



3420 gallons of water containing 100 ppm total electrolytes or 1710 gallons containing 200 ppm total electrolytes. When the unit is exhausted, the resin bed can readily be regenerated without removing the resins from the tank. The plastic regenerating tank is used for both regenerants.

The MBD-15 is supplied piped and partially assembled and requires connecting together only 3 flanges other than the connections to influent, effluent and waste lines.

16", 24" and 30" diam. single bed units
(see photo above)

Diameter of unit	16"	24"	30"
Approx. flow rate (gpm)	10	20	30

Construction of these "package" units is of the same heavy-weight materials used for Permutit's large custom-designed units and includes rugged PVC plastic interior piping and plastic strainers, full 3/16" thick rubber lining steam-cured and vulcanized to the heavy gauge steel shell. The entire lining is spark-tested at 25,000 volts. Exterior piping is high strength plastic.

Standard equipment includes a rubber-lined Permutit multiport control valve for each unit, acid pump, corrosion-proof plastic tank for cation regenerant and steel tank for anion regenerant. All parts are normally kept in stock for immediate shipment and are described in standard drawings.

• • •

For complete information, write to The Permutit Company, Dept. CE-12, 50 West 44th St., New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

PERMUTIT®

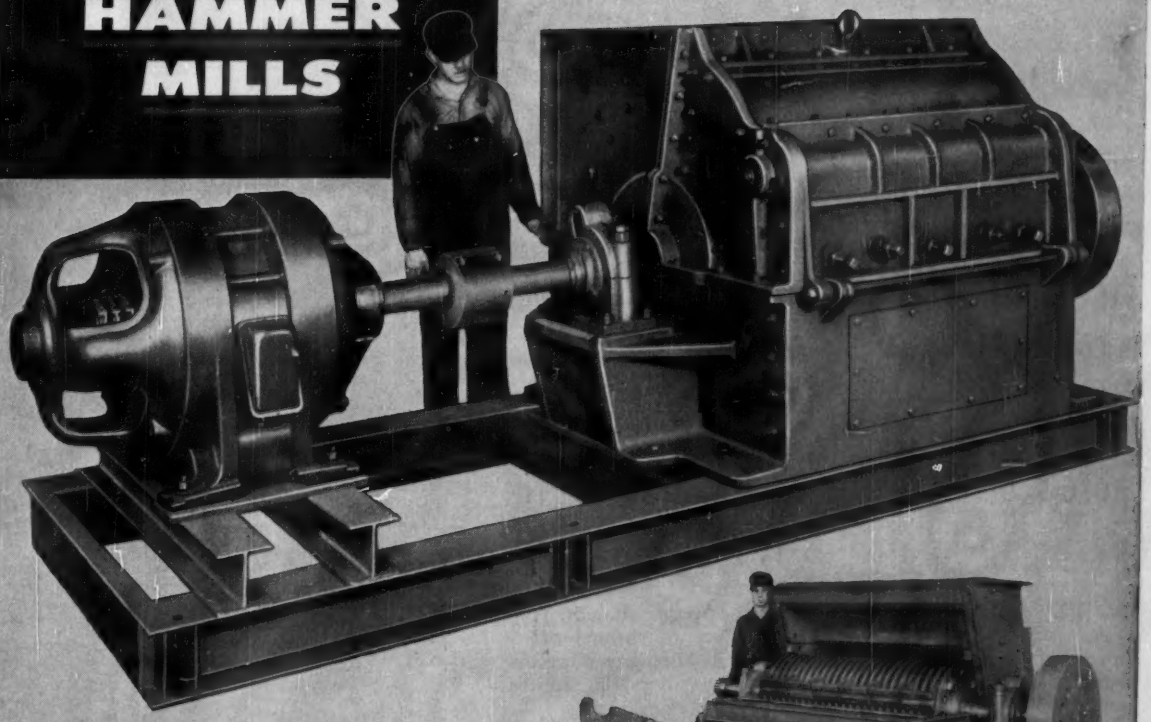
rhymes with "compute it"

A DIVISION OF PFAUDLER PERMUTIT INC.

Water Conditioning

Ion Exchange • Industrial Waste Treatment

WILLIAMS *heavy duty* HAMMER MILLS



- **Crushes, Grinds, Shreds To Finished Size In One Operation**
- **Reduces Production Costs Up To 50%**
- **Saves Up To 75% On Equipment Cost**

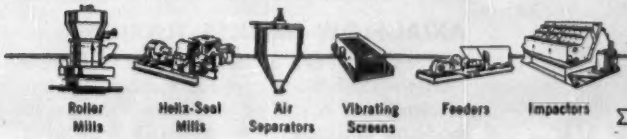
Williams No. 60 GA Mill with heavy duty steel plate frame. Cover has been opened to show heavy duty manganese steel liners, breaker plates, grate bars and hammers.

Whether your size reduction job involves crushing, grinding or shredding—whether the material is mineral, chemical, vegetable or animal—Williams has a hammer mill designed to *do it from start to finish in a single operation.* More uniform product, increased output, plus savings in time and labor can *cut production costs as much as half!*

Extra primary and secondary crushers are seldom required with a Williams—no extra drives or conveyors, no costly foundations or buildings for additional crushers are necessary. Expensive maintenance, replacement parts, excessive downtime and labor are reduced to a minimum.

Learn how a Williams hammer mill can step up your output, and improve your product quality. *Write —explain your operation—and ask for a catalog.*

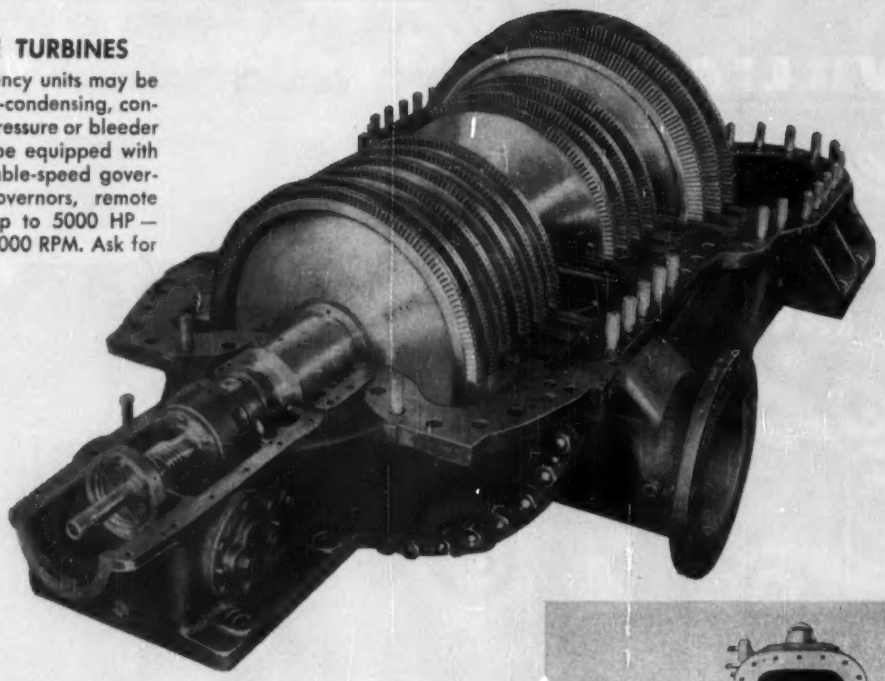
WILLIAMS PATENT CRUSHER & PULVERIZER CO.
2706 N. 9th St. St. Louis 6, Mo.



WILLIAMS
CRUSHERS GRINDERS SHREDDERS
Oldest and Largest Manufacturers of Hammer Mills in the World

MULTI-STAGE TURBINES

These high-efficiency units may be designed for non-condensing, condensing, mixed pressure or bleeder operation. Can be equipped with constant or variable-speed governors, special governors, remote controls. Sizes up to 5000 HP — Speeds up to 10,000 RPM. Ask for Bulletin S-146.



There's a **Terry turbine** for every mechanical-drive requirement

The designs for Terry turbines are based on more than 50 years of successful experience in the manufacture of turbine drives *exclusively*. This specialization has resulted in Terry becoming one of *the leading producers* of mechanical-drive turbines in sizes up to 5,000 horsepower.

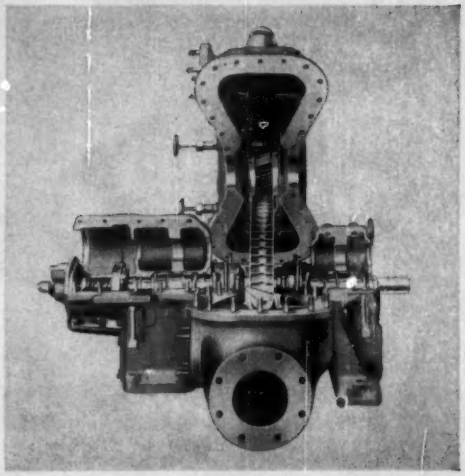
There are three basic reasons why Terry has been able to maintain this position of leadership: (1) a thorough knowledge of the requirements of mechanical-drive turbines, (2) a willingness to build "a little something extra" into each machine to assure trouble-free operation, and (3) an acknowledgement of the company's responsibility to stand behind the performance of every turbine sold.

These are also the reasons why you should consider a Terry turbine for your next mechanical drive. In the meantime, send for bulletins describing any of the types of machines illustrated.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

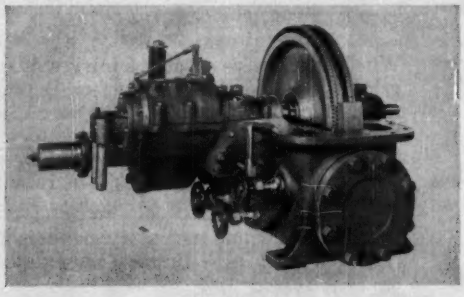
TERRY

TT-1209



SOLID-WHEEL TURBINES

Famous for sure dependability and ease of inspection. Can be started cold — no preliminary warming required. Available in vertical designs depending on frame size. Capacities from 5 to 2,000 HP. Described in Bulletin S-116.



AXIAL-FLOW IMPULSE TURBINES

Built with one, two or three rows of high-grade stainless steel blading, these turbines combine efficiency with durability. Available in designs for moderate and high steam pressure. Bulletin S-143.

SPECIAL FITTINGS Need *NOT* Delay You

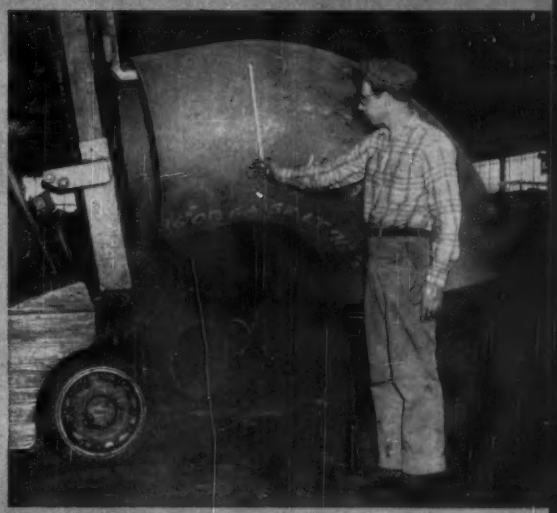
Entire interior and exterior surfaces of special stainless elbows for nuclear power plant are inspected with dye penetrant in search of microscopic surface imperfections. Elbows are 16" O.D. with 102° included angle and long tangent on one end.

Midwest Can Make *and* Deliver

An exclusive and flexible manufacturing process enables us to make welding fittings of any material available in plate that can be worked and welded. As plate is more readily available than pipe, in special materials and thicknesses, deliveries are much better.

Elbows with special included angles, special tangents, special wall thicknesses and of special materials are easily and promptly made. Closer tolerances are inherent in the Midwest process. Quality control always exceeds code requirements . . . can be as comprehensive as you need.

Whether or not you use specials, Midwest Welding Fittings will do a better job for you. Consult your distributor, or write us for new Bulletin 5801.



Note the exceptionally long tangent on one end of this 36" O.D. 90° short radius elbow made of special carbon steel. Similar tangent could have been provided on other end if required.

MIDWEST PIPING COMPANY, INC.

Main Office: St. Louis 3, Mo. (P. O. Box 433)
PLANTS: ST. LOUIS, CLIFTON, N. J. and LOS ANGELES
SALES OFFICES:
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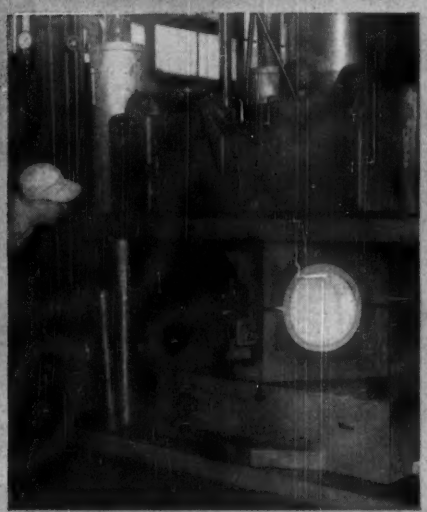
Los Angeles 33—520 Anderson St. • Miami 34—2103 Le Jeune Rd.
New York 7—50 Church St. • Pittsburgh 19, Pa.—437 Grant St.
San Francisco 11—420 Market St.
St. Louis 4, Mo.—1450 South Second St.
Tulsa—1640 E. 21st St.

STOCKING DISTRIBUTORS IN PRINCIPAL CITIES



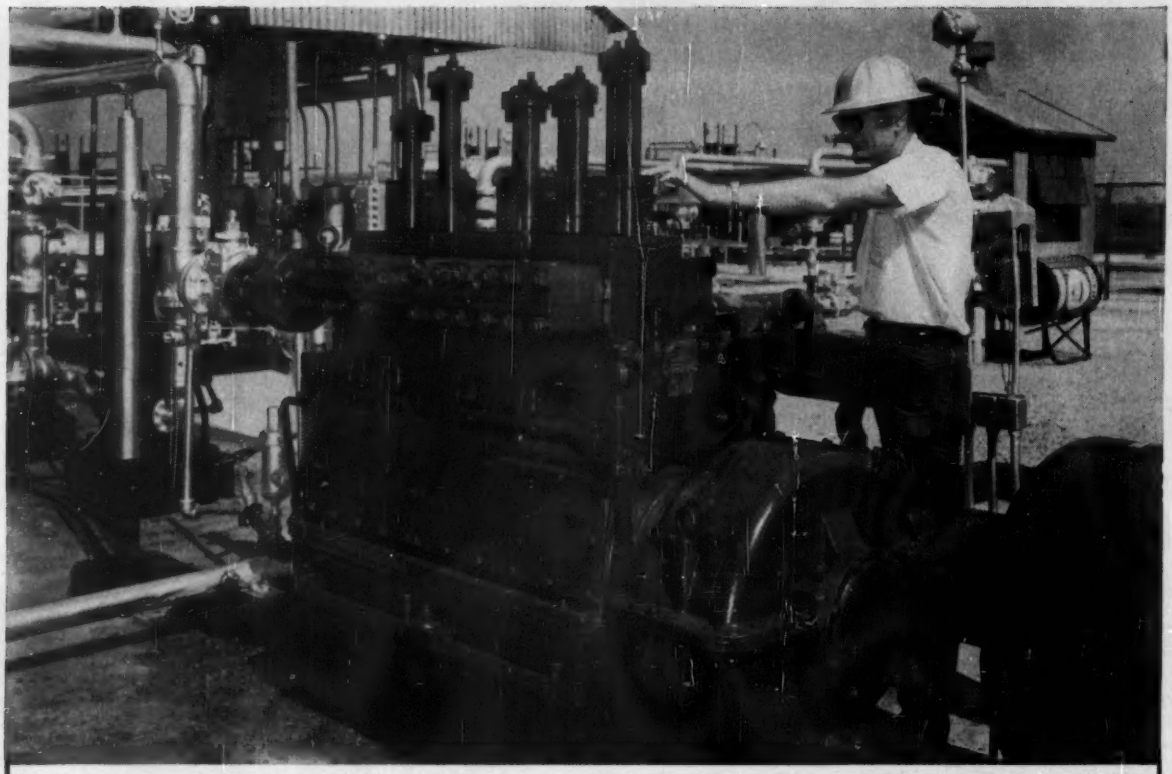
18" O.D. x 1¼" wall 90° elbows (2¼% chrome ½% moly) being sized in compression by totally enclosing dies. The exceptional dimensional accuracy that results is possible only with the Midwest process.

Interior surface of 30" O.D. stainless steel welding elbow for liquid sodium nuclear system required a finish of 125 micro-inches or better.

8060

MIDWEST WELDING FITTINGS

IMPROVE PIPING DESIGN and REDUCE COSTS



FIELD REPORT

SERVICE: LP-Gas Injection
Burnell—North Pettus Cycling Plant

PUMP: 1½"x5" Aldrich Quintuplex

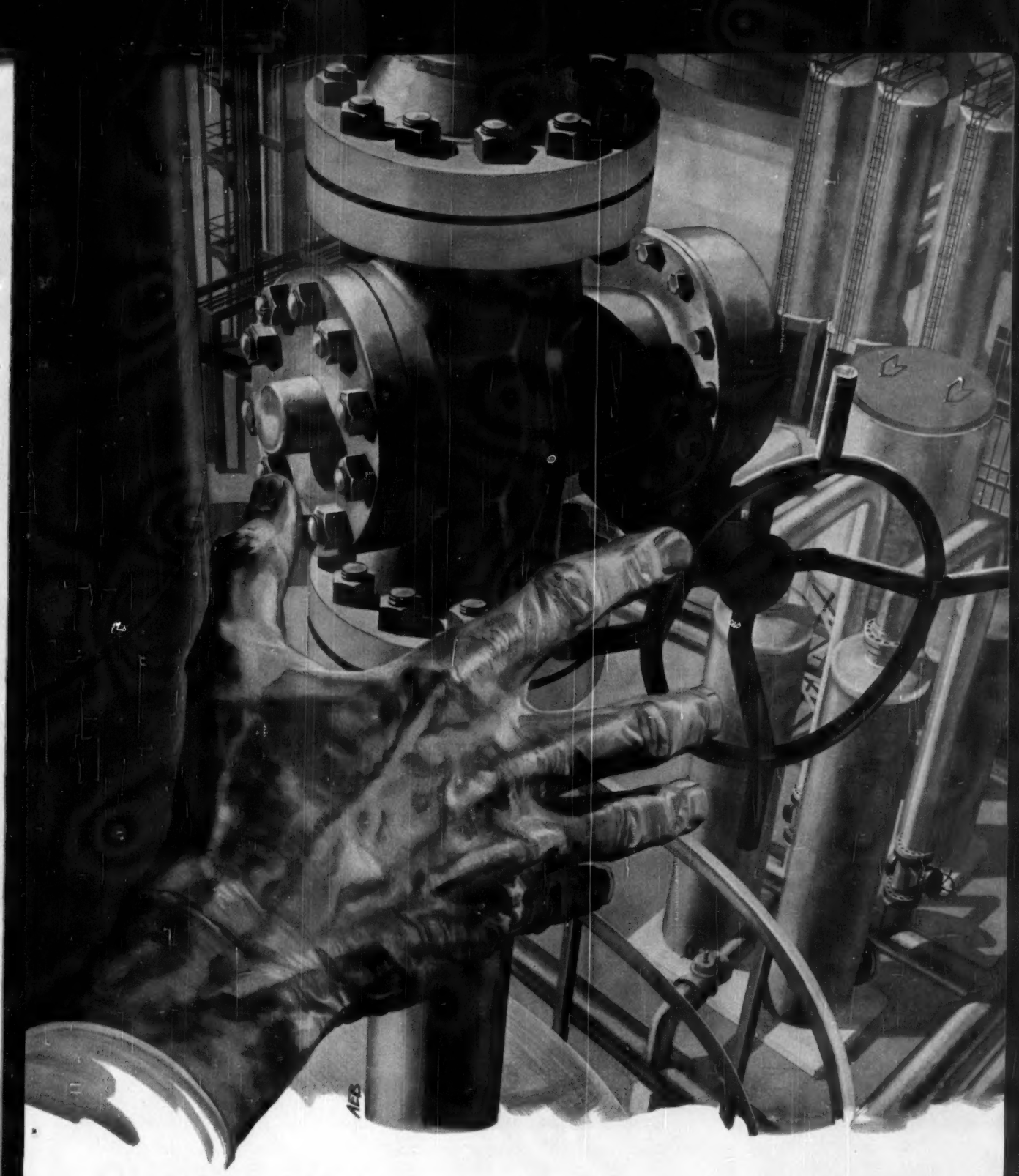
OPERATION STARTED: June, 1950

EXPERIENCE TO DATE:

Continuous service...pump delivers 52 gpm at 3000 psi. Routine maintenance annually...plungers are repacked as necessary. Customer reports: "complete satisfaction" with the performance of the Aldrich pump.

Field parts stock available in Carmi, Ill.; Calgary; Casper, Wyoming; Charleston, W. Va.; Houston; Los Angeles; Odessa and Tulsa. For further information, write the Aldrich Pump Company, 3 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH



OUT BY ITSELF, this valve is too inaccessible to be pampered if it won't work. It's on services like this that you so often see Rockwell-Nordstrom lubricated plug valves. Why? Pressurized lubricant forms a *leakproof seal*, prevents wear, keeps the quarter-turn operation smooth and easy. Proved on tough services, Rockwell-Nordstrom valves naturally work better, stay in service longer and cost less to use.

Available everywhere in a *complete* range of sizes and pressures. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES

it's **ROCKWELL**

MANUFACTURING COMPANY

HOW GOOD IS SECOND BEST?

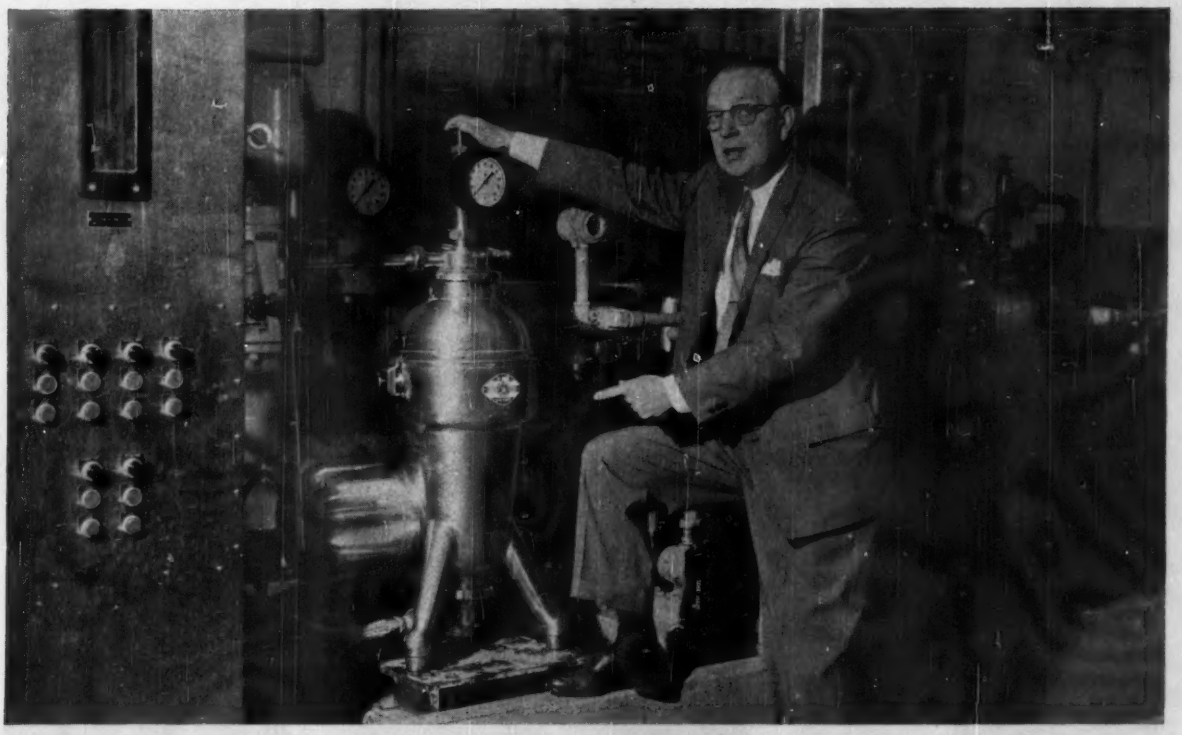
In the oil, gas or process industries, second best is not good enough. That's why you see so many Rockwell-Nordstrom valves where only the *best* is acceptable for critical flow control. Their positive shut-off, easy operation and long-life economy just can't be equaled.

Rockwell-Nordstrom is the world's most complete line of lubricated plug valves and plug valve accessories. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES

it's ROCKWELL

MANUFACTURING COMPANY



"De Laval hermetic centrifuges absolutely eliminate process frothing, oxidation or emulsification."

Fred Wheelwright, De Laval Separator Co.

De Laval Hermetic Centrifuges make possible the fast, continuous processing of liquids otherwise incompatible with centrifugal action. With many of these liquids, processing becomes for the first time both efficient and economical.

It's all a matter of pressure. By maintaining constant pressure (up to 100 psi) from inlet to outlets, the liquids being processed are maintained in a closed system, never have a chance to foam, oxidize or emulsify. There is absolutely no contact with air so product purity is protected in a manner impossible in other methods of clarification and separation.

PRESSURE-SEALED

The De Laval Hermetic Centrifuge is basically the same as the famous De Laval Disc-Type Constant-Efficiency Centrifuge. The important difference is the presence of the special De Laval long-life seals at inlet and outlets. They maintain positive pressure throughout the centrifuging process.

The disc bowl is easily removed for cleaning when necessary, but it is possible in many cases to clean the bowl in-place. This is accomplished simply by feeding water, a detergent solution or a solvent into the outlet and back flushing the discs and bowl walls. With this system, there is no need for stopping and dismantling the machine. Stainless steel discs are standard equipment on all Hermetics.

ESSENTIAL OILS TO SOAPSTOCKS

These are only two of the many diverse materials now benefiting from centrifugal processing with the De Laval Hermetic. Any liquid that is viscous, inflammable or that must be kept free from contact with air may well be processed more efficiently and economically with a De Laval Hermetic. We have three different size conventional solid-bowl Hermetic machines which cover a wide range of applications. And recently we've developed a Hermetic NOZZLE-TYPE centrifuge. It's such a new development we're not sure of *all* the processes where it may be applied, but it shows great promise in several fields. We'd welcome your inquiries.

Operating as a separator, the Hermetic features a special back-pressure control valve on the light-liquid discharge permitting instant adjustments with absolute accuracy for change of relative gravity of light and heavy phases without stopping the machine.

NAME THE LIQUID

If you'd care to send us your process data and samples of your material, we'll be glad to have our engineering staff run pilot plant studies and send you their objective recommendations. They're guaranteed objective because we're the only company that makes Hermetic Centrifuges. If you'd like, your own technical staff can work with De Laval on these tests. No obligation, of course.

Booklets S. A969 and S. A983 give further specifications and operating details. Or to have one of the De Laval Sales Engineers call on you, just drop us a line on your letterhead.

DE LAVAL
SEPARATOR COMPANY

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York
5724 N. Pulaski, Chicago 46, Illinois

DE LAVAL PACIFIC COMPANY
201 E. Millbrae Avenue, Millbrae, Calif.

In-Stock Service

on Carpenter Stainless No. 20 and No. 20Cb

forms, sizes and shapes for most corrosion problems

• Besides keeping our warehouses fully stocked with all forms of Carpenter Stainless No. 20 and 20Cb, we maintain fast, modern facilities to make up and speed your orders to you . . . no matter what your deadline. *Our service teams are geared to handle your most urgent delivery needs.*

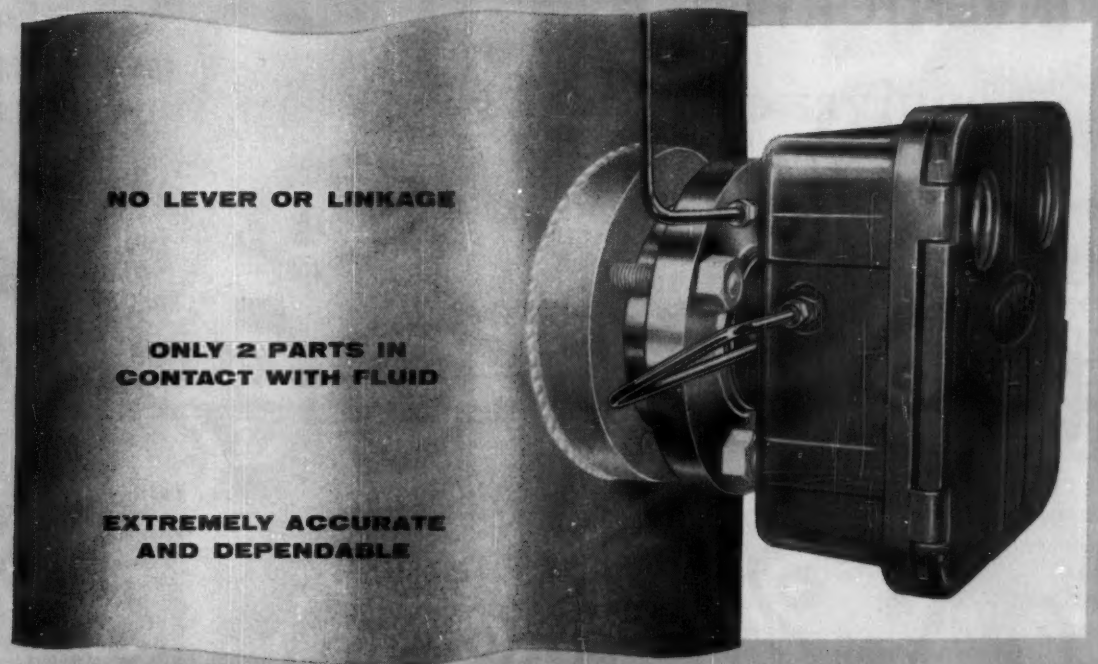
Available from stock in sheet, plate, pipe, tubing, strip, bars, wire and billets, Carpenter Stainless No. 20 and 20Cb are as easily fabricated as ordinary stainless steels. You get long-life control of sulphuric acid and other severe corrodents in a hurry when you order Stainless No. 20 and 20Cb. One installation of this Super-Stainless will outlast most other corrosion-resistant alloys . . . economically. Contact our nearest office or authorized distributor (located in over 40 cities, coast to coast). Write on your company letterhead for technical bulletin 108A. The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

your master key to cost-saving corrosion control

Stainless No. 20 & 20Cb

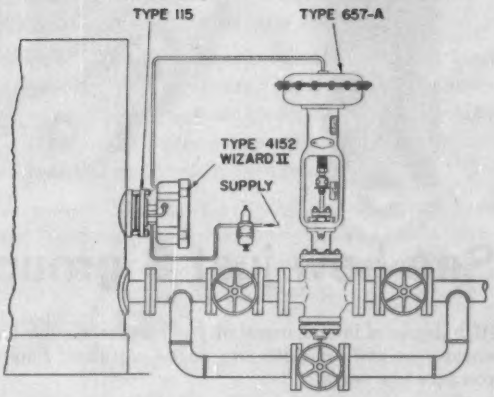
Carpenter Stainless No. 20 bars, strip, wire and billets are available also from The Carpenter Steel Company, Reading, Pa.

For that hard-to-handle liquid... consider the "115" Transmitter



Ideal as a liquid level transmitter for slurries, paper stock, and viscous or corrosive fluids

Flange mounts direct to side of tank. Only the diaphragm and the diaphragm ring come in contact with the fluid. Diaphragm is Teflon impregnated glass cloth ... ring can be stainless steel or some other corrosion resistant material of your choice. Pneumatic output of the "115" is a 1 to 1 measure of the liquid head in the vessel. Frequently supplied with the popular Fisher Wizard II as the controller which makes a complete and compact assembly for liquid level control application. Also used as a transmitter for remote, level indicating, recording or controlling. Primarily for open tank service, the "115" is used in pipe lines and vessels with pressures up to 75 psi. For complete information on the Fisher "115" write for Bulletin F-115.



Fisher "115" with the Wizard II as the controller on a liquid level control installation.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY

FISHER GOVERNOR COMPANY

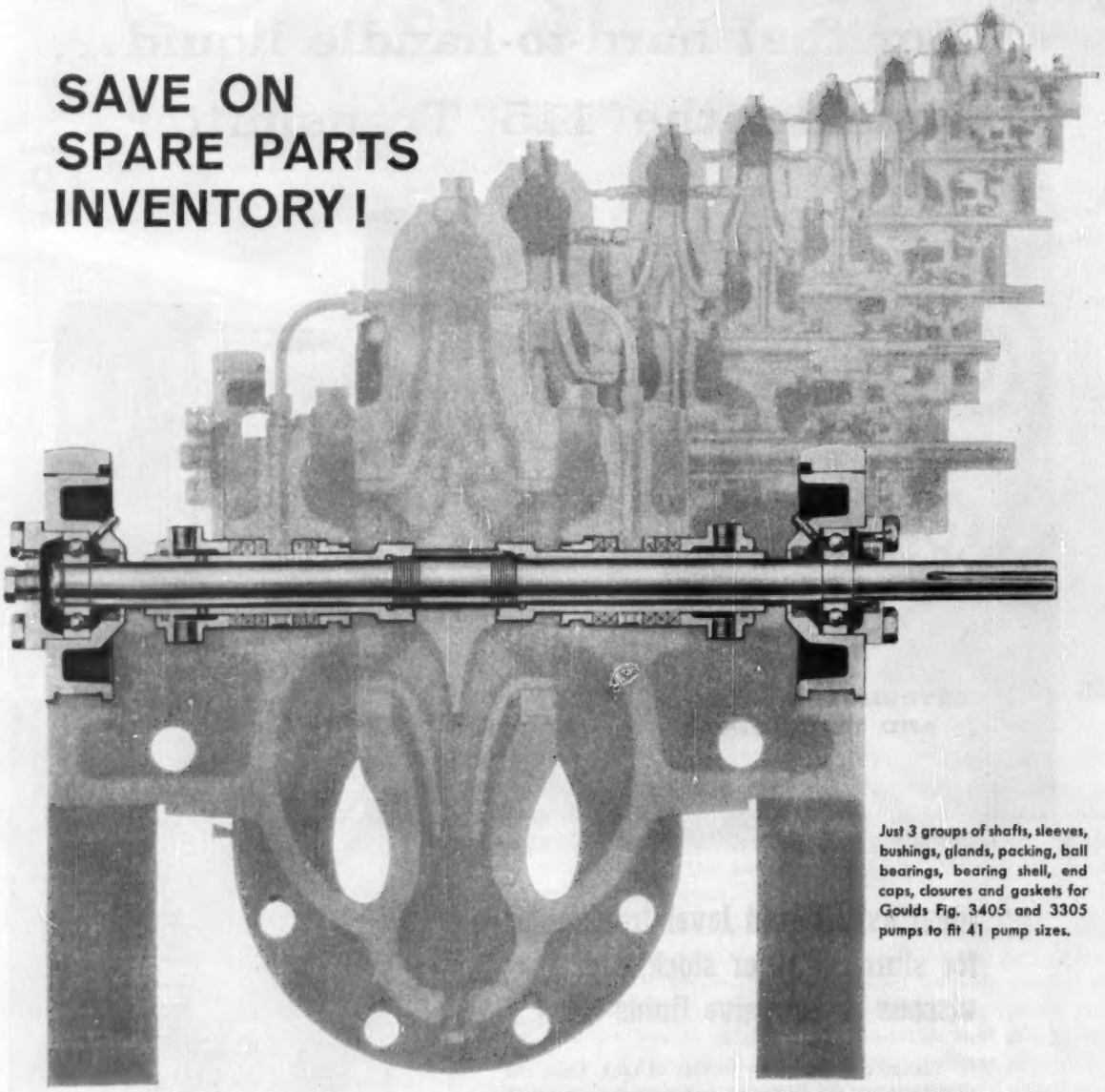
Marshalltown, Iowa / Woodstock, Ontario / London, England

CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

FISHER® Controls

SINCE 1880

SAVE ON SPARE PARTS INVENTORY!



Just 3 groups of shafts, sleeves, bushings, glands, packing, ball bearings, bearing shell, end caps, closures and gaskets for Goulds Fig. 3405 and 3305 pumps to fit 41 pump sizes.

See how just 3 groups of parts fit 41 pump sizes!

High degree of interchangeability of parts on Goulds Fig. 3405 single-stage and Fig. 3305 two-stage Centrifugal Pumps helps you save four ways:

1. You cut down your spare parts inventory.
2. You can make changes in the field to meet new requirements.
3. Off-the-shelf delivery of standardized parts.
4. You can get lower initial cost, due to standardization of parts during manufacture.

Just three shaft and rotating parts assemblies provide for 41 sizes of these two popular pumps. You cut spare parts inventories *up to 91%*, save the cost of unnecessary overstocking.

Up to 82 pump combinations are possible—considering right- and left-hand rotation—and rotation can be changed in the field due to unique sleeve locking device (patented). Mounting dimensions and motor drive bedplates are standardized to facilitate changing without the additional expense of drilling and tapping.

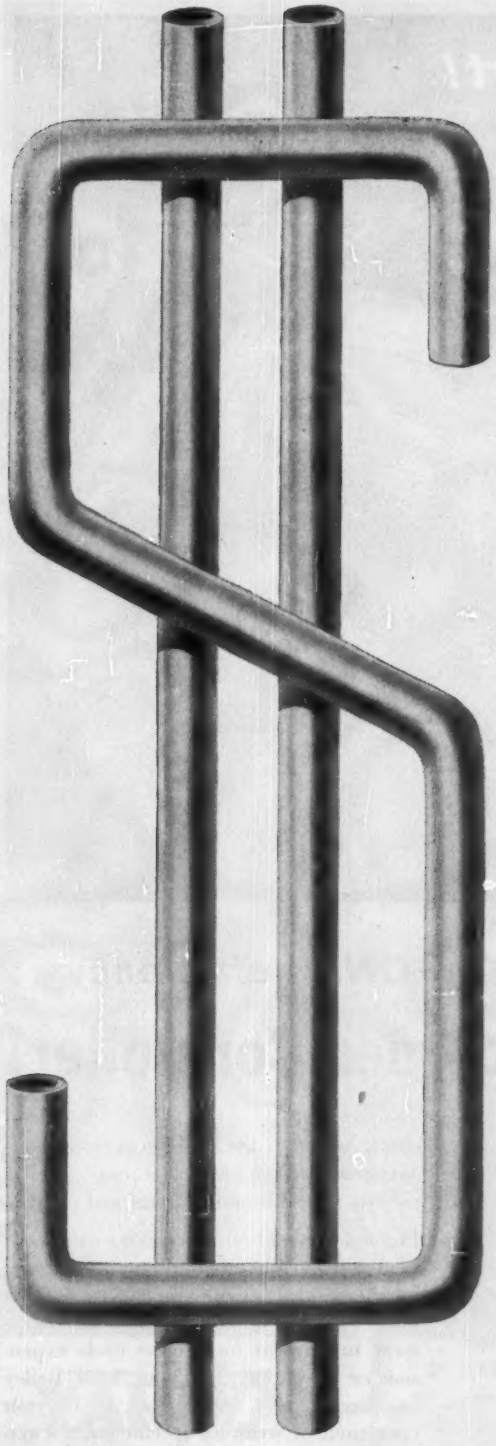
And . . . you get all of this at low cost! Standard parts make manufacture less costly. Goulds passes on the savings to you.

Find out how this maximum interchangeability can save you money by sending for Bulletins 721.6 and 722.6, or ask your nearest Goulds representative.

GOULDS PUMPS, INC., Dept. CE-128, Seneca Falls, N. Y.

GOULDS

PUMPS FOR INDUSTRY



Turn your pressure tube problems into savings

Timken Company metallurgists can select the one steel analysis that gives you maximum tube life-per-dollar

A lot of steels can solve the pressure, temperature and corrosion problem that your particular operation creates. But it takes skill to find the one and only steel analysis that gives you longest tube life for your dollar.

Timken Company metallurgists have the special skill to save you money while solving your pressure tube problem. They're recognized experts backed up by more than 25 years of research and experience in high temperature steels. They've solved hundreds of industry's toughest pressure problems the same way they'll solve yours—economically.

And they've got the steels at their fingertips. You can get Timken® seamless pressure tubes in sizes up to 11″ O.D. x 3¼″ wall—available in all stainless and alloy grades.

One analysis of Timken fine alloy steel will meet your operating conditions best. And you can be sure it's an accurate analysis because we make only electric furnace fine alloy steel and use rigid quality controls to give uniformity from heat to heat, order to order, tube to tube.

Get in touch with Timken Company metallurgists next time you have a pressure problem. They'll solve it the only way they know—economically. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

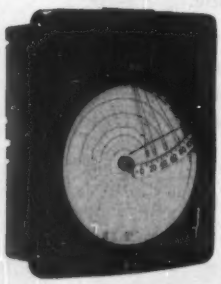
TIMKEN *Fine Alloy* **STEEL**

TRADE-MARK REG. U. S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

To give your operation "FOUR-IN-ONE" efficiency...

The BAILEY Receiver Recorder-Controller!



Records four variables on one chart.

You can lower the cost of your equipment investment and increase the efficiency of your entire operation with the Bailey Receiver Recorder.

HERE'S HOW

The interchangeable components for the Recorder make it fast, inexpensive, and automatic to do up to *four* measuring jobs at the same time with either or both pneumatic and electric systems.

This Bailey unit continuously and simultaneously records four variables on the same chart. And, they are *in the same linear scale measurement.* You have clear, easy-to-read records for continual analysis and control.

Plug-in, pre-calibrated receivers can easily be adapted on-the-job to revised process requirements. The Bailey Receiver Recorder saves you money with a minimum instrument investment for process cycle expansion or alteration. Let your local Bailey engineer suggest applications to fit your operation. Or write for specific control systems information for your entire plant operation.

CP105-1

Chemical and petroleum division

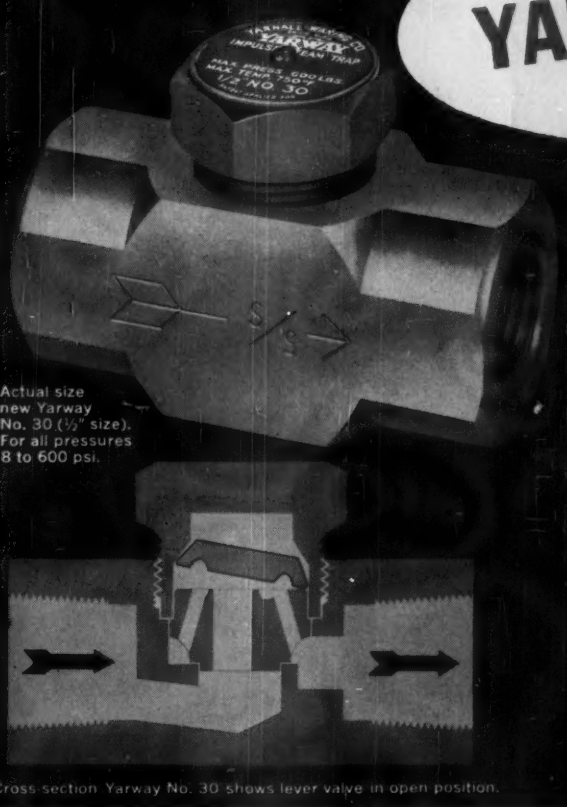
BAILEY METER COMPANY

1054 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal

NEW YARWAY IMPULSE* STEAM TRAP ENGINEERED FOR YOUR LIGHT LOAD REQUIREMENTS

YARWAY NO. 30



Actual size new Yarway No. 30 (½" size). For all pressures 8 to 600 psi.

Cross-section Yarway No. 30 shows lever valve in open position.

- **Economy of operation on light loads**
  - Closer shut-off
  - Quieter operation due to lever action
- **Economy of Maintenance**
  - Replaceable valve-seat assembly
  - One moving part
  - Stainless steel construction

Put this trap on tracer lines, steam line drips and other light load applications. Order from your local Yarway distributor.

For free bulletin, write Yarnall-Waring Company, 100 Mermaid Ave., Philadelphia 18, Pa.

*IMPULSE . . . A COMPLETE LINE OF STEAM TRAPS, OPERATING ON A PROVEN THERMODYNAMIC PRINCIPLE.

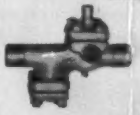
YARWAY impulse®

OVER 1,250,000 ALREADY SOLD

USE THESE YARWAY IMPULSE TRAPS FOR ALL OTHER STEAM TRAP NEEDS

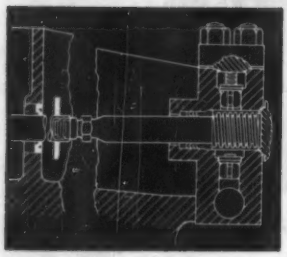
NORMAL NEEDS Famous Series 60 Impulse traps (pressures to 400 psi) and Series 120 (pressures to 600 psi) meet most normal needs

EXTRA HEAVY CONDENSATE LOADS Series 40 Impulse traps have extra large capacity to handle large volumes of condensate

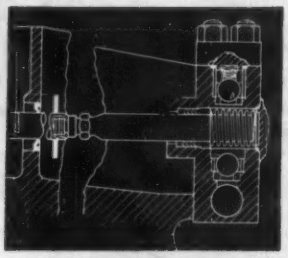


POWER PLANT AND MARINE SERVICE Yarway Integral Strainer Traps fill the bill for marine and high pressure power plant jobs

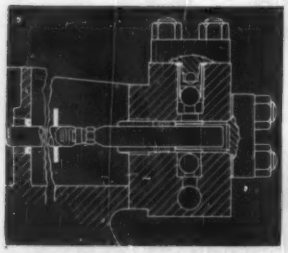
Name Your Triplex Pumping Problem **GAULIN** has a Maintenance-Saving Answer



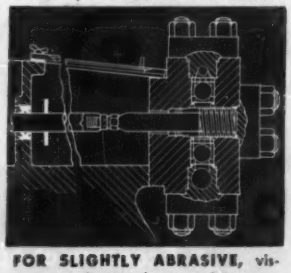
FOR FLUID, non abrasive products the Gaulin Spring-Loaded Poppet Valve provides low initial cost and low maintenance.



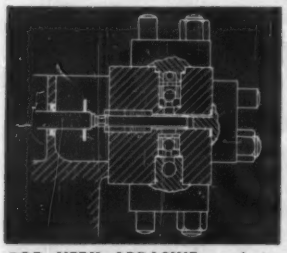
FOR VISCOUS, heavy-bodied products, the Gaulin Ball Valve (spring-loaded packing, inserted seats) provides excellent pumping efficiency and minimum maintenance.



FOR SLIGHTLY ABRASIVE, viscous products, the Gaulin Ball Valve (adjusting screw packing, inserted seats) keeps maintenance costs down.



FOR SLIGHTLY ABRASIVE, viscous products, where maintenance must be accomplished in minutes, the Gaulin Ball Valve with removable seats (spring-loaded packing) cuts maintenance time to the bone.



FOR VERY ABRASIVE products, the Gaulin Ball Valve (with adjusting screw packing, removable seats) provides the ultimate in low cost maintenance.

Name Your Capacity

There's a Gaulin to handle your capacity from 50 GPH to 6,500 GPH.

Name Your Pressure

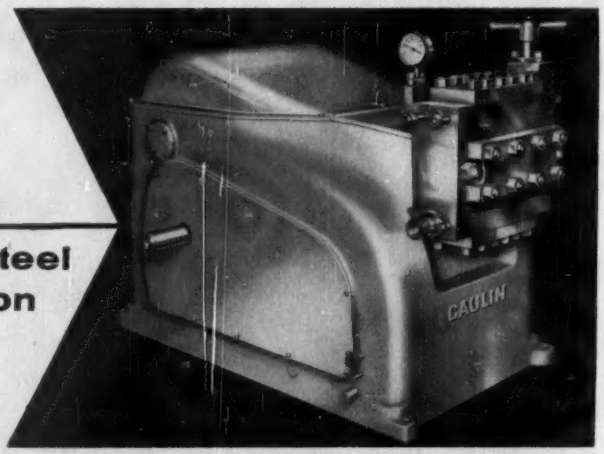
Gaulins are designed for pressure ranges — 500 to 12,000 psi.

Name Your Product

Only Gaulin designs a specific cylinder to handle every product efficiently, economically. Note some of our designs shown and described at the left.

Horizontal Design

Stainless Steel Construction



For Transfer, Metering, Spray Drying

A Gaulin Triplex Pump is a rugged, heavy-duty machine built to minimize operating, inspection, and maintenance costs. Compact. Simple. Dependable. Its horizontal design positively separates your product from the crankcase . . . and makes every part easy to get at.

Just lift two plates and a Gaulin drive and plunger assembly is convenient for inspection or repair.

A Gaulin Cylinder may be disassembled in a matter of minutes, cuts maintenance time to the bone!

Vibrationless. A Gaulin is practically free of vibration.

Corrosion-proof. All product contacting parts are stainless steel. Ceramic plungers or other materials are available for special applications.

Rugged Dependability. Thousands of installations with well-known companies prove a Gaulin provides unusually long service at minimum cost.

Write for new bulletin. Ask for No. P-55.

MG/166-1

Gaulin TRADE MARK

Manton-Gaulin

Manufacturing Company Inc., 71 Garden St., Everett 49, Mass.

OXYGEN

the exact amount you need

You get it instantly—from LINDE

You have no worries whatever about an ample, dependable supply of oxygen for your process when you buy oxygen from LINDE. Full responsibility for production, transportation, and storage at your plant is assumed by LINDE.

Tonnage oxygen. Large amounts of liquid or gaseous oxygen can be supplied from a full-scale oxygen production unit—built and maintained by LINDE—directly to your plant. You pay only for the oxygen you use, at a price guaranteed by LINDE, with no capital investment on your part.

For varying needs. A DRIOX oxygen storage unit provides a continuous flow of liquid oxygen, or converts it automatically to gas. Constant pressure is maintained, even while the unit is being replenished. Or you can get LINDE oxygen in a single flask, a cylinder, or banks of cylinders.

Take advantage of LINDE's 50 years of development and service in the industrial gas field! Write, phone, or wire Dept. CG-123, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

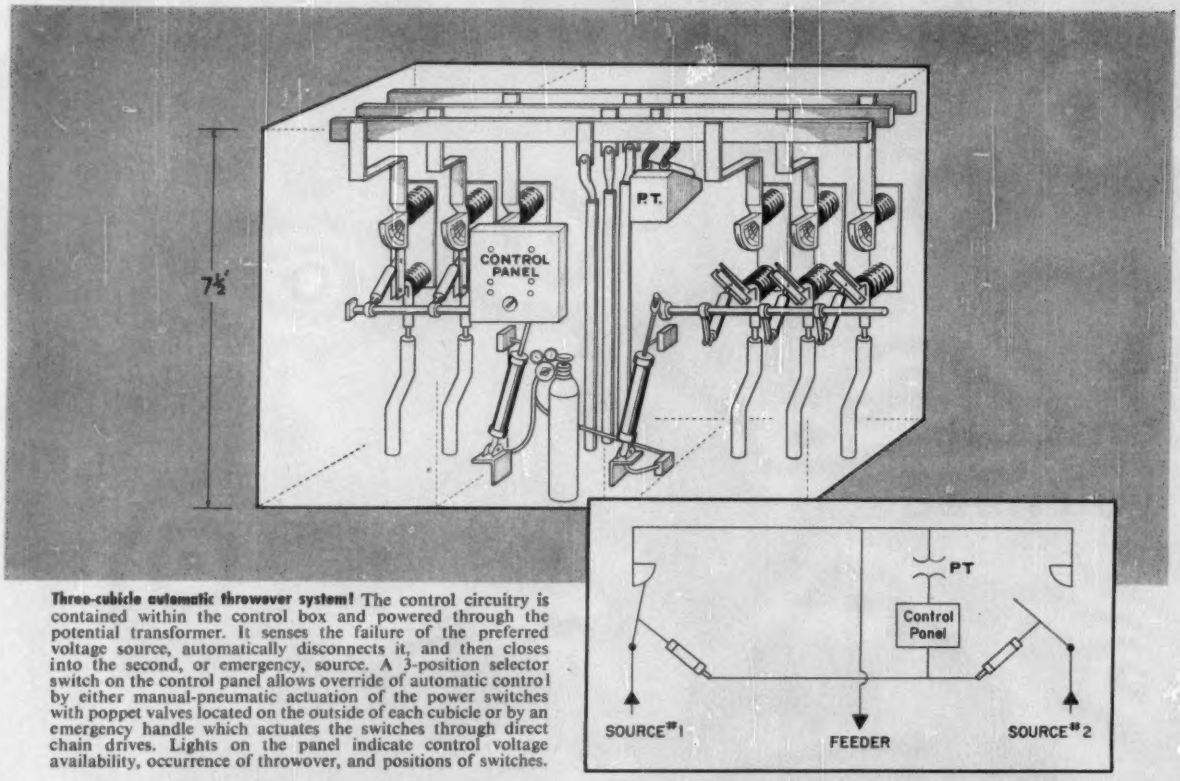
When you need Oxygen—call LINDE!

Linde TRADE-MARK

UNION CARBIDE

The terms "Linde," "Driox," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

R&IE POWER SWITCHING CENTERS



Three-cubicle automatic throwover system! The control circuitry is contained within the control box and powered through the potential transformer. It senses the failure of the preferred voltage source, automatically disconnects it, and then closes into the second, or emergency, source. A 3-position selector switch on the control panel allows override of automatic control by either manual-pneumatic actuation of the power switches with poppet valves located on the outside of each cubicle or by an emergency handle which actuates the switches through direct chain drives. Lights on the panel indicate control voltage availability, occurrence of throwover, and positions of switches.

AUTOMATIC POWER CONTROL

Simple, lower-cost automatic throwover for assured service continuity ...now available with R&IE's Electro-Pneumatic Power Switching Centers

For continuous industrial processes, where shutdowns due to loss of voltage are intolerable, an R&IE Power Switching Center with automatic throwover can serve you as an ever-vigilant switchman, ready to go into action whenever service continuity is endangered. Its operation, simple and straightforward, consists of constantly monitoring load circuit voltage and, upon loss of it, automatically switching to a substitute source. Electrically controlled, with pneumatically actuated power switches, this system can provide you with dependable automatic power control at a cost significantly lower than comparable systems using motor or hydraulic actuation. Energy requirements of the pneumatic system are extremely low.

The force used to actuate the HPL-C power switches is provided by double-acting, heavy duty air motors. Pneumatic pressure is provided by a standard nitrogen cylinder or by dry compressed air from the plant system. One cylinder contains sufficient pressure for up to 500 complete operations. The pneumatic system, including nitrogen cylinder, air motors, and all controls, is mounted in a separate metal enclosed compartment. Provision is made for disengaging the air motor from the switch linkage to test the pneumatic system.

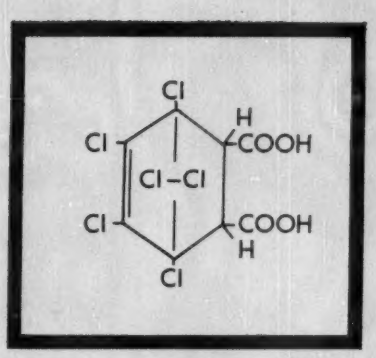
Power switching centers with automatic throwover can be supplied with any number of individually enclosed outgoing feeders up to 2000 amp. And additional feeders can be added —easily and economically—at any time. Each feeder can be controlled by a directly or remotely operated HPL-C power switch rated for safe closing into 3-phase faults of up to 250,000 kva—up to 1,000,000 kva with current limiting fuses.

Only one potential transformer is required in the load circuit for adequate sensing and power for the simple automatic throwover, manual return system shown. In addition to this and other automatic throwover systems, R&IE Power Switching Centers, in ratings from 4.8 through 14.4 kv, can be equipped with automatic controls for overload protection, operation from ground fault relaying equipment, or other special condition. For complete information, contact your nearest I-T-E sales office or write R&IE Equipment Division, Greensburg, Pa. In Canada: Eastern Power Devices Ltd., Port Credit, Ont.

I-T-E CIRCUIT BREAKER COMPANY
R&IE EQUIPMENT DIVISION • GREENSBURG, PA.

BRIEFS

on a highly chlorinated new intermediate... some phosphorus chemicals for igniting... new booklet on benzoic acid and sodium benzoate... an exhaustive chlorine manual



New intermediate is 54.7% stable chlorine

This is Het® Acid, also known as chlorendic acid. It is a versatile intermediate which undergoes typical dibasic acid reaction.

It's 99.5% pure in the form of fine, white crystals. The stable, high chlorine content makes it exceptionally useful for imparting flame retardance to various derivatives.

Forms salts with a variety of metals. Both mono- and di- sodium salts are easily formed.

Forms esters by the usual methods to produce dimethyl, diethyl, dipropyl, etc. Rate of esterification is quite rapid.

Forms anhydride by dehydration at high temperatures.

Forms amines and *amides*.

Forms resins with glycols and other polyols and with fatty oils to make flame-retardant oil-modified alkyds.

These are just a few of Het Acid's reactions which have commercial interest. For a cursory glance at the whole story send the coupon for technical data sheet or, if you'd like to go into this even deeper, send for our Bulletin 40.

Some things have to burn

Got a product you want to ignite in air—like a firecracker, or a match, or a fuse, or a signal flare?

We make two different chemicals that will help get it started: red phosphorus and phosphorus sesquisulfide.

The red phosphorus is 99.4% pure and ignites in air at 200°C. The particle size is 99% min through 100 mesh.

The phosphorus sesquisulfide is a lemon yellow compound completely free of untrapped phosphorus. It ignites by friction. 90% goes through an 80 mesh screen. 80% goes through 100 mesh.

Technical data on both compounds offered in the coupon.

New booklet on benzoic acid and sodium benzoate

If you would like facts on these two chemical cousins in one compact little booklet, check the coupon for Bulletin 323.

It's chock full of useful data on both Hooker chemicals in both their U. S. P. and Technical Grades.

Free Chlorine manual

If you'd like 76 pages of facts on chlorine, send the coupon for Bulletin 125.

There's a lot of information on the chemical itself, including charts and graphs on its physical properties.

There's lots more on how to handle chlorine safely. Descriptions of equipment and containers should make it easier to run a safe chlorine handling program.

Finally, there is a listing of the advantages you enjoy as a user of Hooker chlorine. Dependable delivery, in scrupulously clean containers, is the important one. But there are many others.

For more information check here and mail with your name, title, company, and address.

- ☐ Het Acid, Technical Data Sheet
- ☐ Het Acid, Bulletin 40
- ☐ Red Phosphorus
- ☐ Phosphorus Sesquisulfide
- ☐ Bulletin 323
- ☐ Chlorine Manual

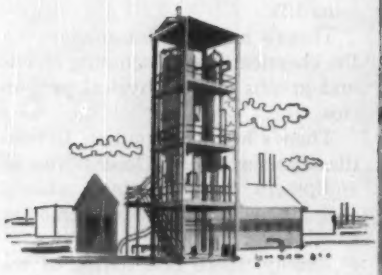
When requesting samples, please use business letterhead to help speed delivery.

HOOKER CHEMICAL CORPORATION
412 FORTY-SEVENTH STREET, NIAGARA FALLS, N. Y.

Sales Offices: Chicago Detroit Los Angeles New York Niagara Falls Philadelphia Tacoma Worcester, Mass.
In Canada: Hooker Chemicals Limited, North Vancouver, B.C.

HOOKER CHEMICALS PLASTICS

Pilot plant reactor shell *after 2000 hours service. Note corrosion on stainless steel shell and flange, while titanium liner shows no corrosion effects. Right: Titanium dip-tube after 2000 hours operation remains free of corrosion damage.*



In high-temperature nitric acid service...

TITANIUM WINS TOUGH 2000-HOUR CORROSION TEST

A large petrochemical company recently tested titanium versus other metals in high-temperature nitric acid service. 6% to 10% concentrations were handled in a pilot plant reactor at temperatures between 300° to 400°F.

Above you see dramatic proof of titanium's performance in this punishing service. After 2000 hours, the reactor's titanium liner and dip-tube showed no corrosion effects, while the stainless steel shell and flanges were badly corroded.

Further corrosion-rate tests were made by immersing test coupons of various metals in the reactor for 40 hours. Again, test results proved titanium's outstanding corrosion resistance (see chart at right).

Want more information? Write for bulletin on Corrosion Resistant Properties of Titanium.

CORROSION RATE TEST
Conditions: 375° F, 300 psig, 6% nitric acid

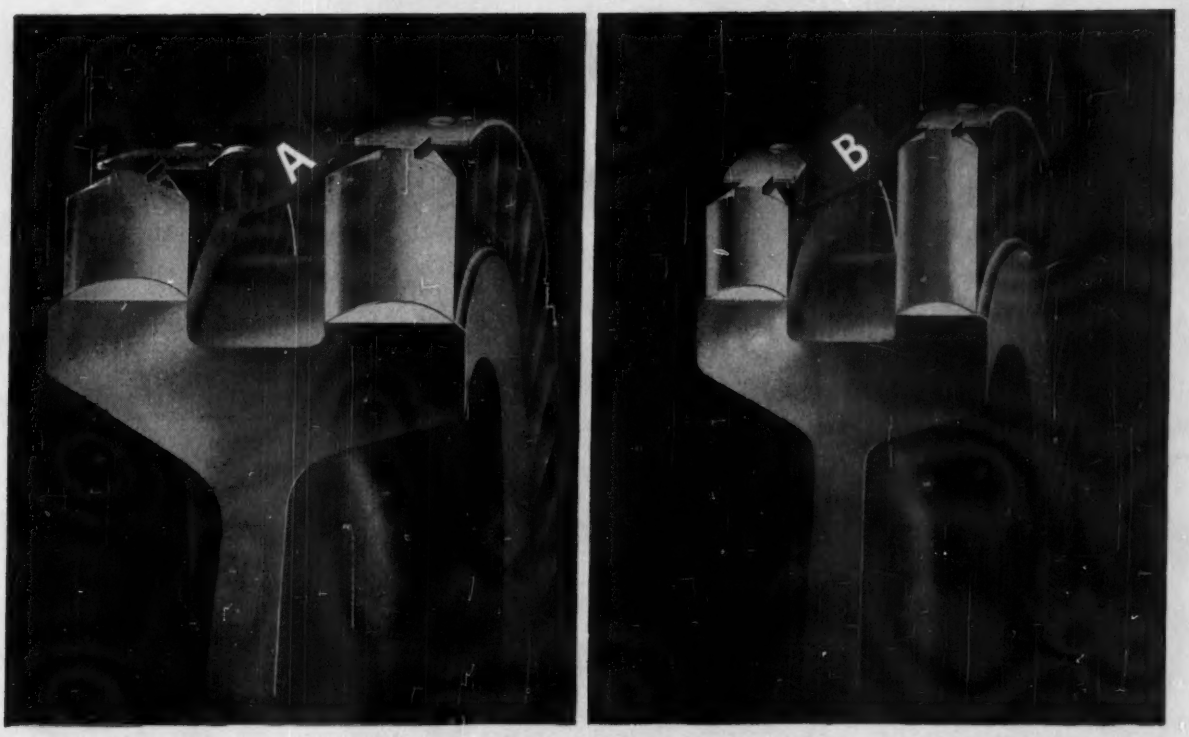
Material	Corrosion Rate mils/yr
Titanium	nil
347 stainless steel	59
304 stainless steel	170
310 stainless steel	274
410 stainless steel	402
309 stainless steel	485
Nickel-Chrome Alloy	20,500

See our 4-page ad in Chemical Engineering Catalog, Pages 1147-1150, for additional technical information.

MALLORY SHARON

MALLORY-SHARON METALS CORPORATION · NILES, OHIO

Integrated producer of Titanium • Zirconium • Special Metals



(Left, A) wide bucket "L" type wheel. (Right, B) regular type wheel for Coppus Steam Turbines

Now...for low steam consumption – **COPPUS TURBINES** *can be furnished with wide bucket "L" type wheel*

Good news for steam turbine users where low steam consumption is important!

The Coppus Type "L" Wheel is the answer to this problem. Larger turbine buckets are employed to make the most economical use of steam.

In every respect the Coppus Turbine offers the top-quality features and advantages that have made the Coppus line outstanding for efficiency and economy. For example:

- Turbines rated close to your exact hp requirements, from 150 hp down to fractional. No need to buy a bigger, costlier turbine than your conditions call for.
- A larger number of steam nozzles, controlled individually by manually operated valves.
- Exclusive pilot operated excess speed safety trip supplementing constant speed governor.
- Replaceable cartridge type bearing housings.
- Optional carbon ring packing glands.

Coppus Steam Turbines ranging from 150 hp down to fractional, in 6 frame sizes, *make turbine dollars go farther.* Send for Bulletin 135 on Coppus Turbine.

COPPUS ENGINEERING CORPORATION
233 Park Avenue
Worcester 2, Mass.
Sales offices in
THOMAS' REGISTER

COPPUS "BLUE RIBBON" TURBINES

New Invention Cuts Waste Disposal Costs By Two-Thirds in Chemical Processing Plants

Industry Cost Averages May Be Lowered Soon

If your plant is average, you're probably spending between .55 and .85 cents for every cubic yard of waste or trash moved to the disposal area . . . not including truck operation costs.

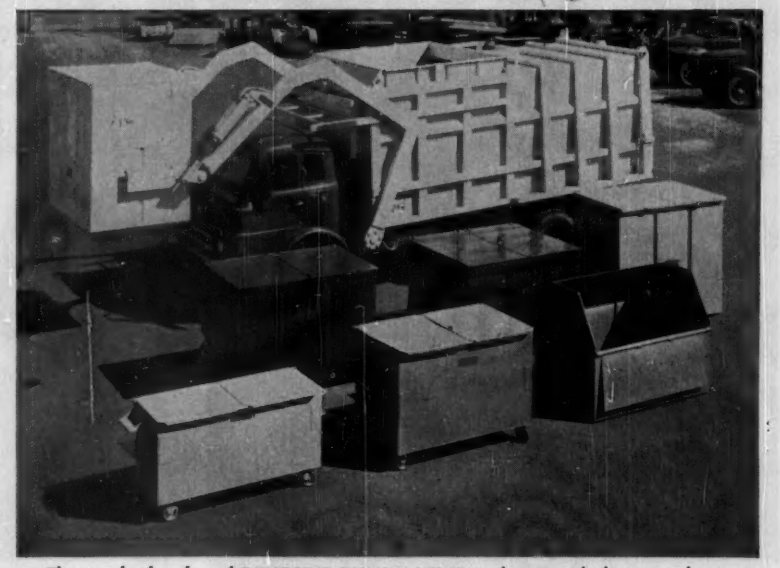
A recent development, the DEMPSTER-DUMPMASTER self-loading packer, promises to cut direct disposal costs to a new industry low of .07 to .16 cents per cubic yard for volume producers.

This new approach is an extension of the widely-established DEMPSTER-DUMPSTER System, in that it employs detachable waste storage containers. However, instead of carrying each container to the disposal area for dumping, the new machine empties many containers into its body, where the material is compacted to a fraction of its former volume. This permits per-trip payloads of 50 to 100 cubic yards of loose material, depending on its characteristics.

Multiple exposure photo shows dumping of 6 cu. yd. container.

How it Operates

The one-man Dumpmaster makes its rounds from container to container. Approaching, the driver engages lifting channels on the container's sides with the clearance arms. From controls in the cab, or remote controls at the front bumper, the container is lifted and rotated, discharging waste into the packer body. The material is hydraulically compacted while enroute to the next location. Containers may also be handled from docks or below grade. The safety clearance arms never pass the cab windows, eliminating possibility of driver injury.



The newly developed DEMPSTER-DUMPMASTER is shown with the seven basic containers it serves. Being hoisted is a 6 cu. yd. model. On ground are 1, 2, 3, 4 and 5 cu. yd. designs. Open container is used for hand-loading service.

New "Tracking" Caster Developments Make Plant "Container Trains" Practical

To whip the high cost of moving refuse outside, many plants are going to "container trains." Using special casters and couplers, eight to ten containers are towed by "plant mules" to inside generation points where an empty is dropped off and the full one is coupled on. Outside, the containers are uncoupled and automatically emptied by the waiting DUMPMASTER.

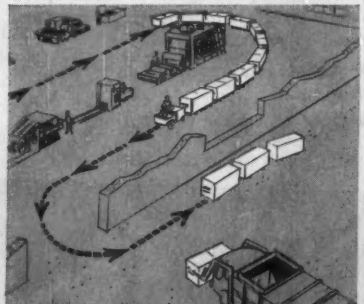


Diagram shows containers, in train, being hauled outside for emptying.

* * *

Many Designs Available

Standard and special-purpose containers, ranging from one through six cubic yard capacity, with or without casters, are available. The two cubic yard container above holds the equivalent of over 12 30-gallon trash cans.

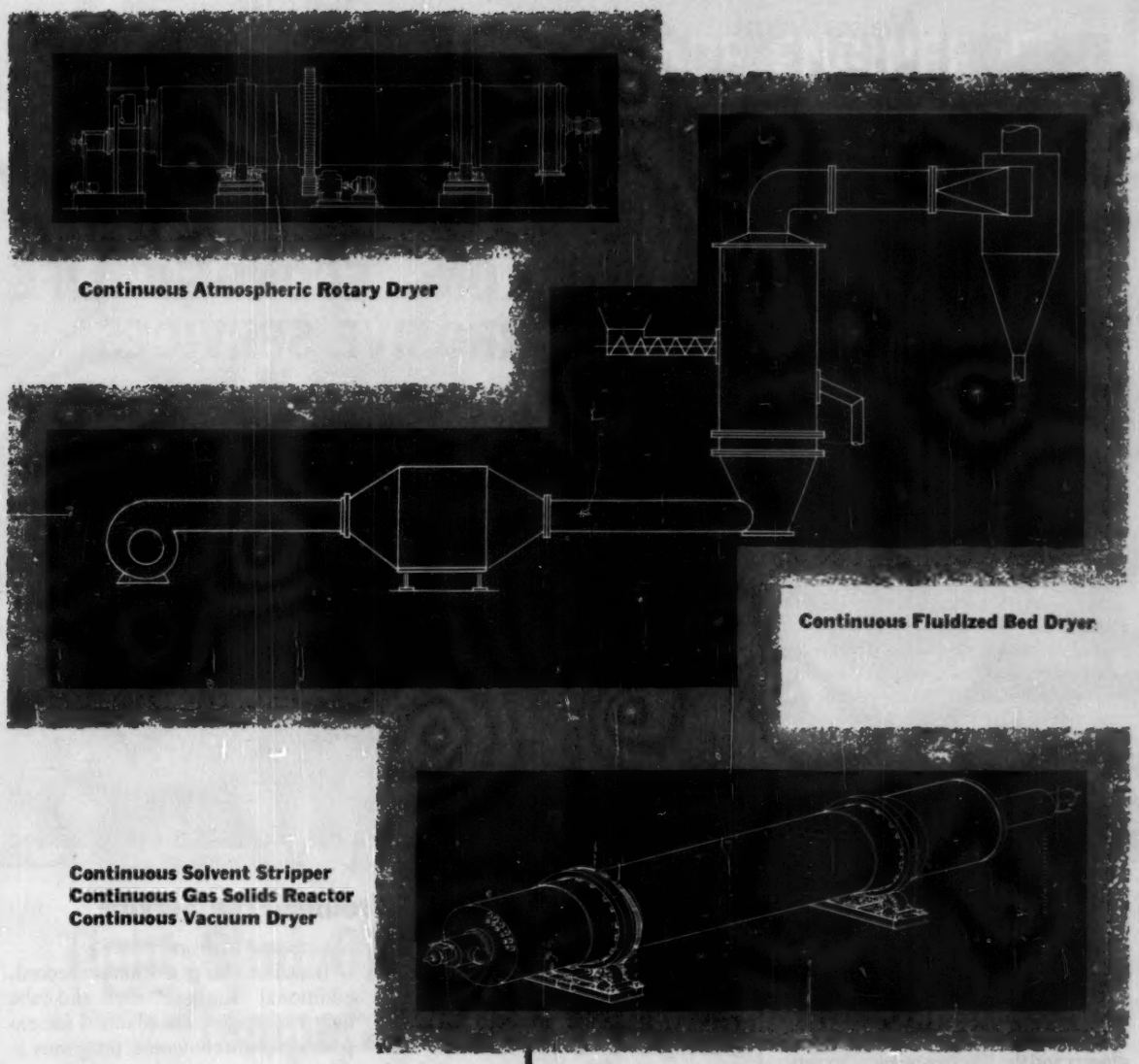
Cost-Finding Book Offered

Write for the free 40-page book, "How to Cut Waste Disposal Costs," offered by the manufacturer. It contains cost-finding formulas, solutions to problems, case histories, industry average costs, etc. Equipment demonstrations arranged on request.

Mfd. by Dempster Brothers, Inc.

DEMPSTER BROTHERS

KNOXVILLE, TENN., DEPT. CE-12



Continuous Atmospheric Rotary Dryer

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Continuous Solvent Stripper
Continuous Gas Solids Reactor
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Now, at one convenient location, you can test-dry your materials in a variety of equipment

At General American's East Chicago pilot plant, you can test the drying or reacting of your materials in the widest range of drying equipment ever assembled in one place.

Louisville Dryer engineers will work with you—study your materials and needs, make recommendations for type of equipment, size and heating medium. You can check these recommendations for yourself through practical tests. Your Louisville Dryer is then engineered for most efficient and economical service—built specifically to meet your needs.

To test the drying of your materials in all these different types of drying equipment, call in a Louisville Dryer engineer. There is no cost or obligation.

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Marketing Manager, Chemical Products

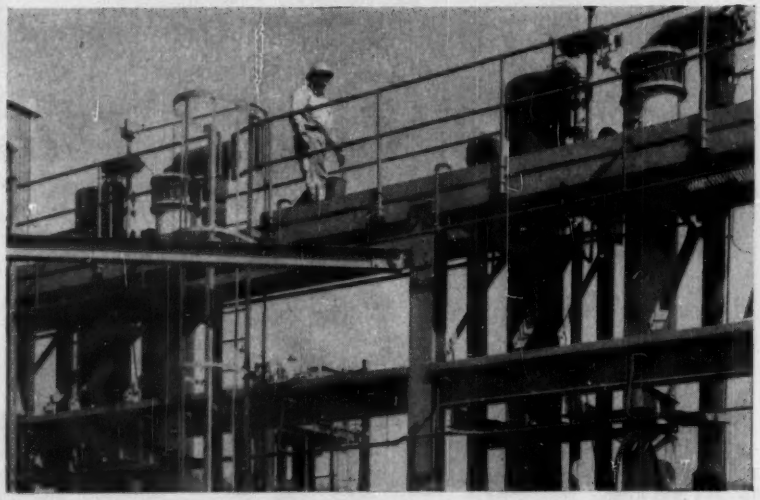
W. W. PALMQUIST

Mr. Palmquist was graduated from Yale University with a B.S. in Chemical Engineering. He has spent ten years preparing design proposals, developing new designs and improving existing designs of "Karbate" chemical processing equipment. Based on this extensive design and development background, Bill was made Manager of Sales Promotion and Development for the Chemical Products Sales Department.

For the past year, Bill has been Chemical Products Marketing Manager and is responsible for marketing the complete line of "National" carbon and graphite products and "Karbate" impervious graphite for the chemical processing and allied industries.

He is a member of the American Institute of Chemical Engineers, the National Association of Corrosion Engineers and the Electrochemical Society.

"KARBATE" CONDENSERS PROVIDE LONG, ECONOMIC LIFE IN CORROSIVE SERVICES



A bank of 4 "Karbate" condensers in an organic chemical plant.

10 to 15 Years of Trouble-Free Service

Eleven shell and tube heat exchangers have proved the excellent corrosion resistance of "Karbate" impervious graphite material. These exchangers have provided ten to fifteen years of trouble-free operation in condensing a highly corrosive *chlorinated hydrocarbon.*

Based on this performance record, additional "Karbate" shell and tube heat exchangers are planned for expansion and renovation programs in this plant.

"KARBATE" Condenser replaces Silver Condenser

To overcome the silver condenser problems of high-cost, specialized fabrication and exacting maintenance procedures, a "Karbate" shell and tube condenser was installed by a major chemical company in an *acetic anhydride* condensing application.

The unit is handling 80% *acetic anhydride* vapor at a temperature of 100°C.

The replacement "Karbate" impervious graphite unit has provided excellent heat transfer and examination after 20 months of service show it to be as good as new.

NATIONAL CARBON FABRICATES 20-FT. LONG "KARBATE" TUBE HEAT EXCHANGER

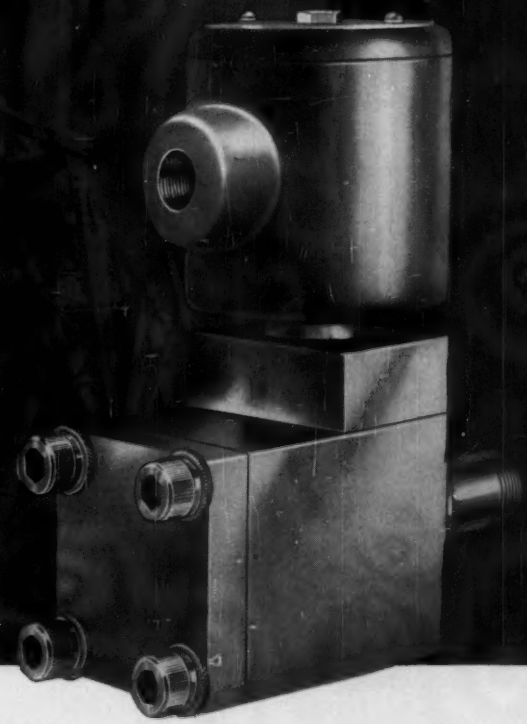
National Carbon Company was requested to replace a steel bundle in an existing all steel shell and tube heat exchanger. This presented a problem of 20-foot long tubes plus a two pass shell side arrangement. Photograph below illustrates the design of the "Karbate" baffle system used to reproduce the two pass shell feature. The 20 foot "Karbate" tube bundle was installed in the customer's existing steel shell and is now in service.

NATIONAL TRADE-MARK

The terms "National", "Karbate", "N" and Shield Device and "Union Carbide" are registered trade marks of Union Carbide Corporation.

UNION CARBIDE

ASCO SOLENOID VALVES ARE ENGINEERED TO MISSILE GROUND SUPPORT REQUIREMENTS

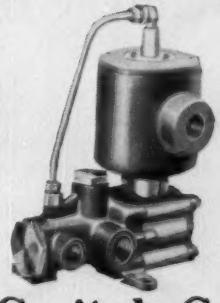


Tight Shut-Off at Pressures to 3000 PSI, Temperatures to Minus 350°F.

ASCO now brings you a family of solenoid valves, specially designed for missile applications with tough environmental or operational requirements. Two, three and four way valves are available with standard, explosion-proof or watertight solenoids; sizes range from ⅜" through 2½". Fluids handled include air, liquid oxygen, helium and nitrogen (liquid and gaseous). Valves can be supplied with continuous duty coil windings for 24 volts D-C, and for any other commercial voltages required. All types are packless (hermetically sealed), providing tight shut-off, with no external leakage to atmosphere.

Two Way Valves . . . normally open or normally closed, easily handle fluids at pressures to 3000 psi, temperatures to -350° F. Valves are stainless steel with teflon discs; most sizes are available with AN connections (Main Illustration-Bulletin 8223X).

Three and Four Way Valves . . . are suitable for piloting cylinder operated valves. Three way valves are also utilized for controlling single acting cylinders, and diaphragms; four way valves are used for controlling double acting cylinders. Unique poppet type seats and discs assure tight seating at pressures to 750 psi, temperatures to -65° F. Valve shown below (Bulletin 8344X) is suitable for 4 way applications, or may be used for 3 way installations by plugging one cylinder connection.



Proposals are submitted upon receipt of specifications—or an ASCO Engineer can help you in solving your ground support valving problems.

For additional information on ASCO Solenoid Valves for Missiles, write for Publication V5056.

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AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

ASCO®

PRACTICE . . .

PROCESS FLOWSHEET

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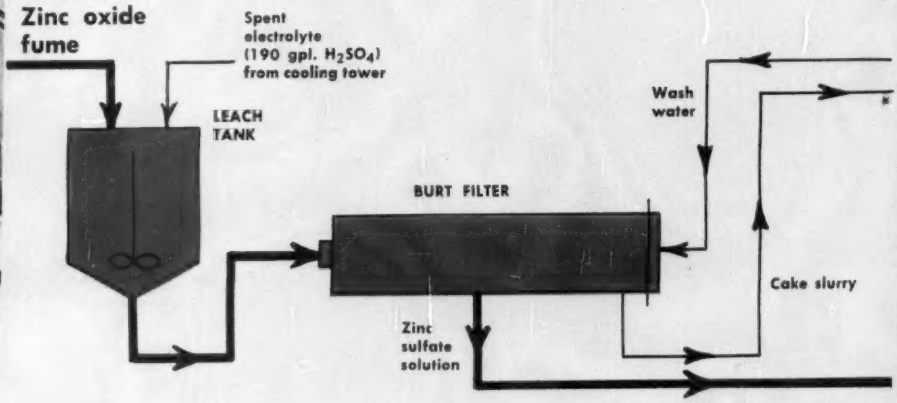
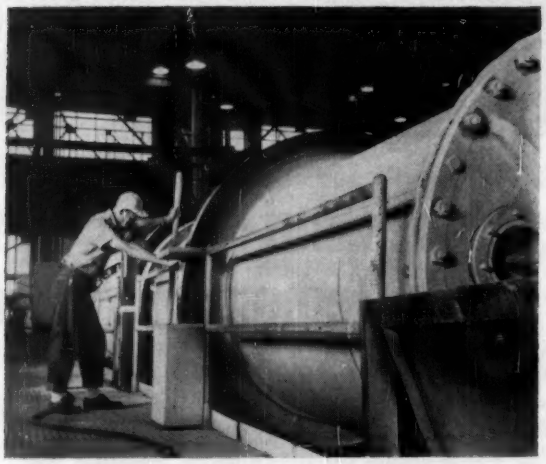
LOADER charges fume to process.



BURT FILTERS remove undissolved solids by pressure filtering through cloth fixed to inside of rotating drum.



By adding alloy facilities to its Corpus Christi zinc plant, Asarco lowers alloy costs and gains greater quality control.

Integrated Zinc Refinery Delivers Alloys, Too

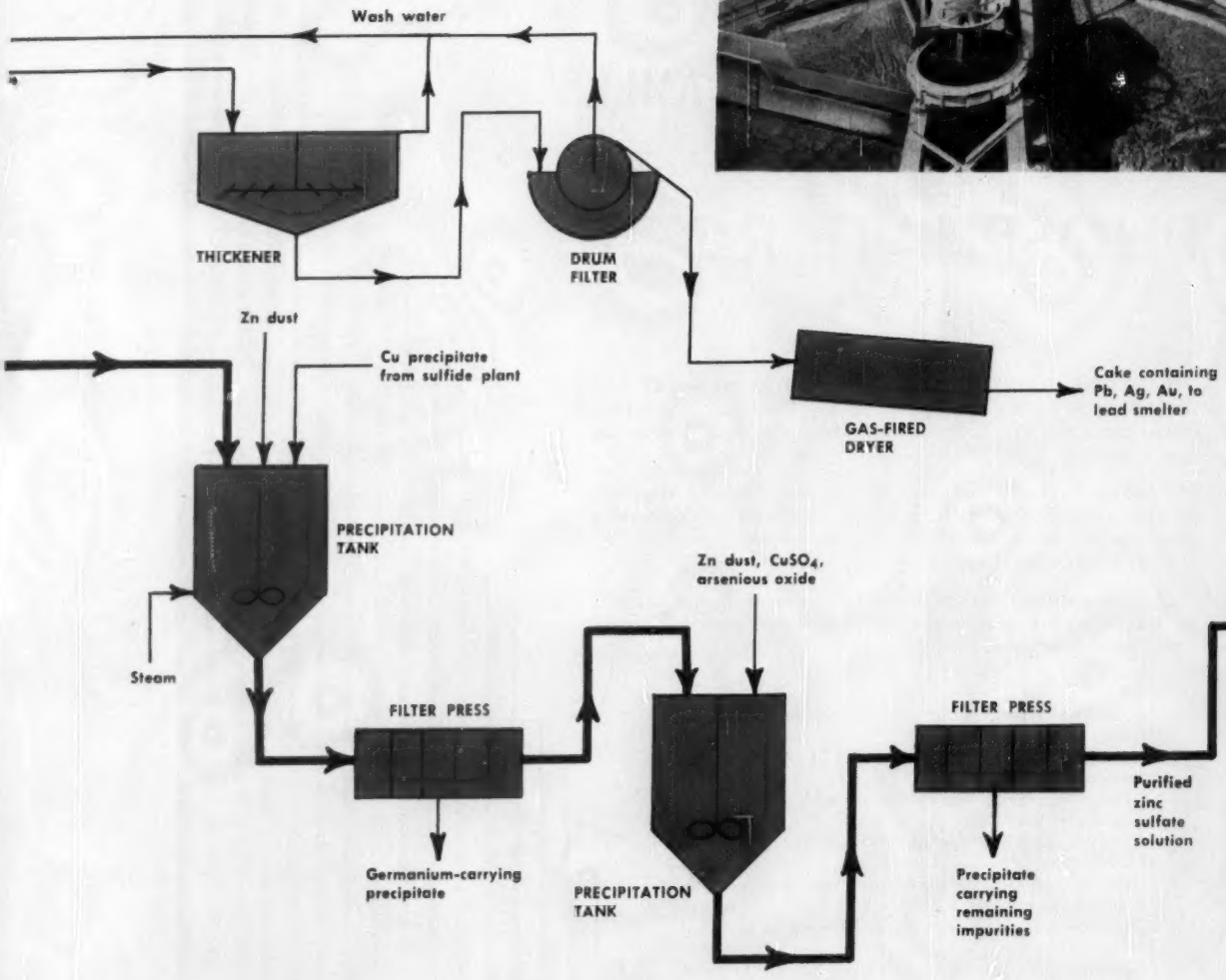
Consolidation of zinc alloy operations with an electrolytic refinery at Corpus Christi, Tex., marks American Smelting & Refining Co.'s latest move in a six-year-old program aimed at closer integration of zinc production activities. Abandoning several smaller alloy facilities scattered throughout the country, this latest step gives Asarco closer control over alloy quality and has paved the way for price cuts on high-grade die-casting alloys.

Previously, Asarco shipped electrolytic zinc slabs from Corpus Christi to the local alloying plants, where zinc was remelted and cast with alloying metals. Now, at Corpus Christi the alloying metals are added to molten zinc tapped directly from the melting furnace—saving one melting operation and consequently giving higher alloy purity.

About 400,000 tons of zinc die-casting alloys are utilized annu-

Unfold Flowsheet

THICKENERS, FILTERS ready solids from Burt filters for drying.



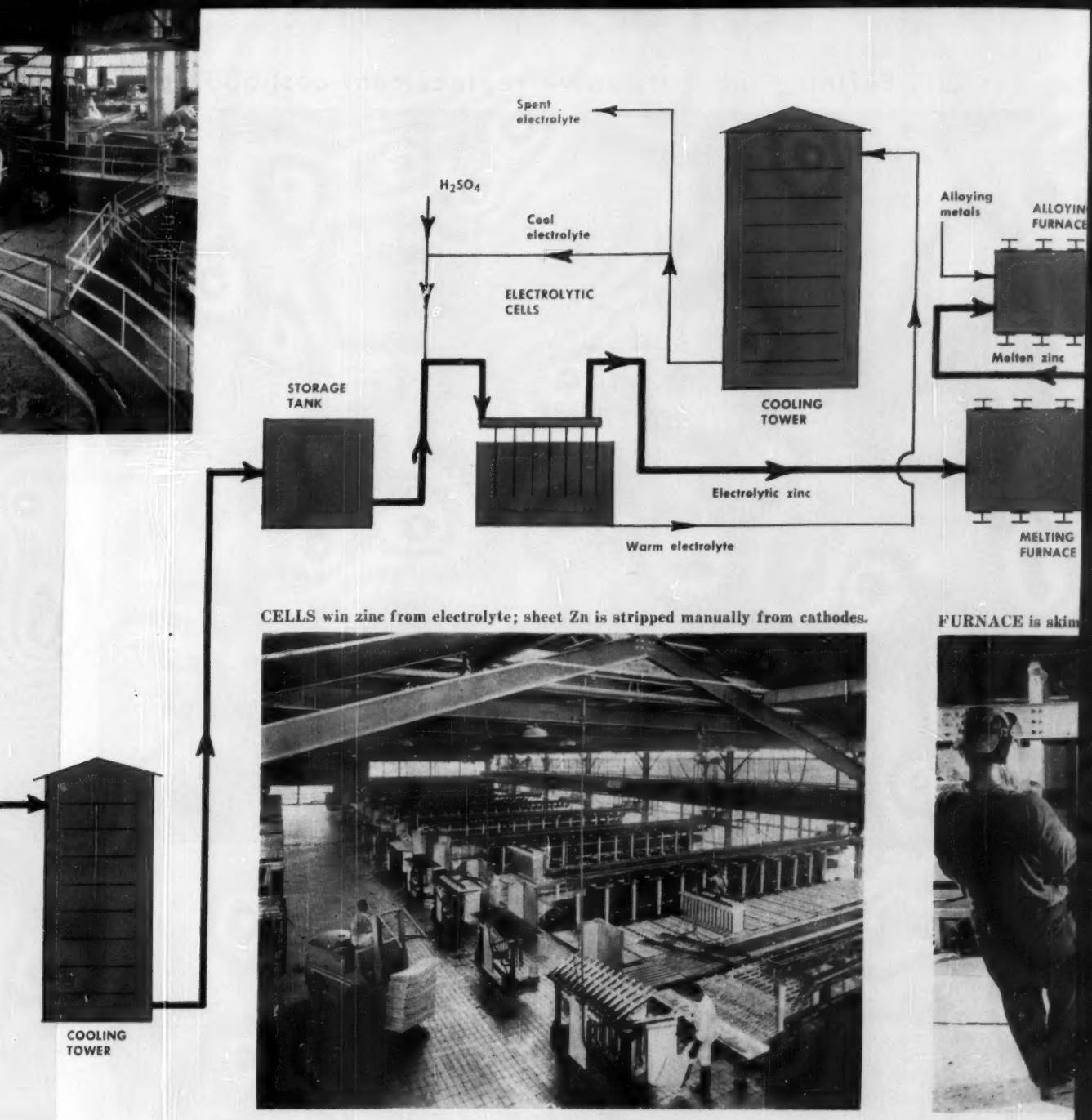
ally in the U.S., with the lion's share going to the automobile industry. Chrome-plated parts, such as grilles and door handles, have a zinc alloy base. Too, carburetor bodies are fabricated from zinc alloys because of their superior casting properties.

▶ **Profits From Byproducts** — By setting up plants to treat secondary products, Asarco is wringing more profit from the basic ores it feeds to its metals plants.

First step in Asarco's integration program came in 1953 when a second plant was erected at Corpus Christi adjacent to the original plant that uses zinc sulfide ore concentrates as raw material. Second plant wins zinc from zinc oxide fume—a byproduct from company's El Paso, Tex., lead smelter. Up to that time, Asarco sold the oxide fume to other zinc producers.

Capacity of the second plant was doubled in 1956 to handle additional oxide fume from firm's Chihuahua, Mex., lead smelter. Since the oxide fume contains relatively large amounts of germanium (which ruins electrolytic deposition of zinc), oxide plant was made separate from sulfide plant to allow for special precipitation steps. Except for the sulfide roasting step, however, basic flowsheet for the two plants is essentially the same. (Flowsheet above depicts only the oxide plant.)

▶ **Product Array**—From two basic raw materials, zinc sulfide concentrates and zinc oxide fume, the Corpus Christi plant not only makes electrolytic zinc and alloys



CELLS win zinc from electrolyte; sheet Zn is stripped manually from cathodes.

FURNACE is skim

(8,800 tons/mo.) but also a host of related products: 5,500 tons/mo. sulfuric acid (from SO_2 liberated in sulfide roasters), 120 tons/mo. zinc sulfate and 70,000 lb./mo. metallic cadmium. Recovered germanium is shipped to El Paso for further processing and eventual sale to germanium oxide refiners.

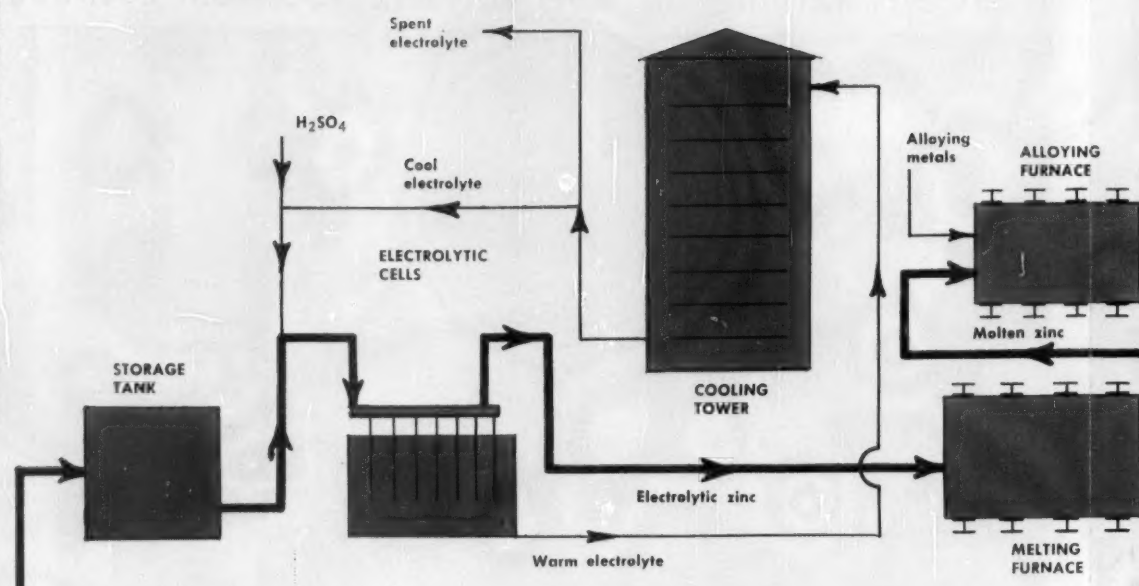
▶ **Start With Oxide**—Zinc oxide fume (77% ZnO—remainder Pb, Cu, Si, Fe and CaO) arrives in bottom-dump railroad cars and is discharged into hoppers beneath railroad tracks. Belt conveyors and bucket elevators carry fume to concrete storage bins.

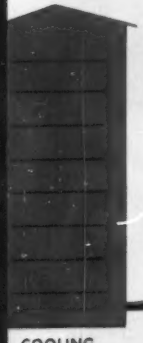
Front-end loaders transport fume to drying and grinding section: Rotary gas-fired dryer eliminates moisture and fume is charged to a ball mill in series with an air classification system. Ground oxide (100% through 100 mesh) is discharged into two 500-ton steel storage bins.

▶ **Then Leach**—Oxide is leached in spent electrolyte (190 gpl. H_2SO_4) from the electrolytic cells. There are three mechanically agitated leach tanks, each holding 2,000 gal.

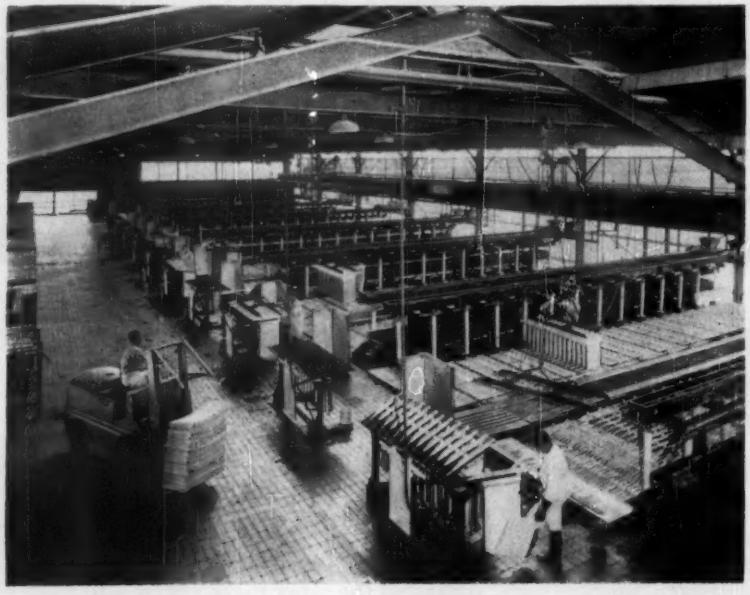
Leach pulp is filtered and washed in a bank of Burt rotary pressure filters. Zinc sulfate filtrate is pumped to the purification section. Cake is washed from filter with water, and cake slurry is thickened, filtered and dried. Dry cake is shipped to El Paso for recovery of silver, gold, copper and lead values.

▶ **Eliminate Germanium**—Two precipitations remove dissolved impurities from zinc sulfate solution.




COOLING TOWER

CELLS win zinc from electrolyte; sheet Zn is stripped manually from cathodes.



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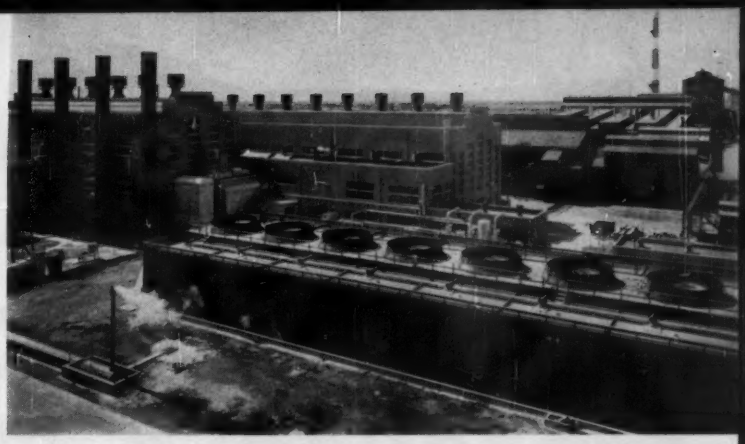
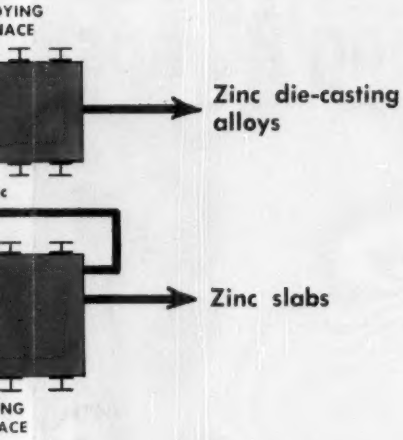
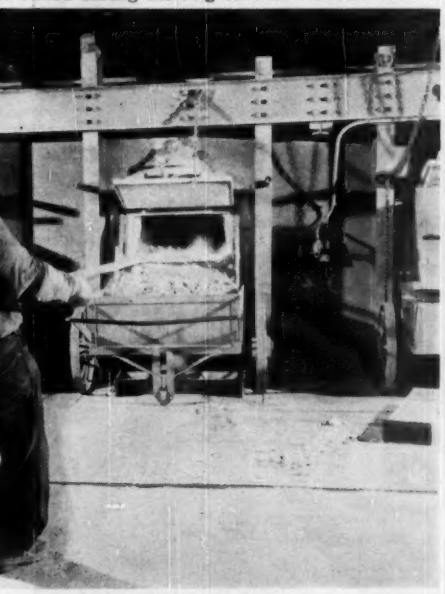
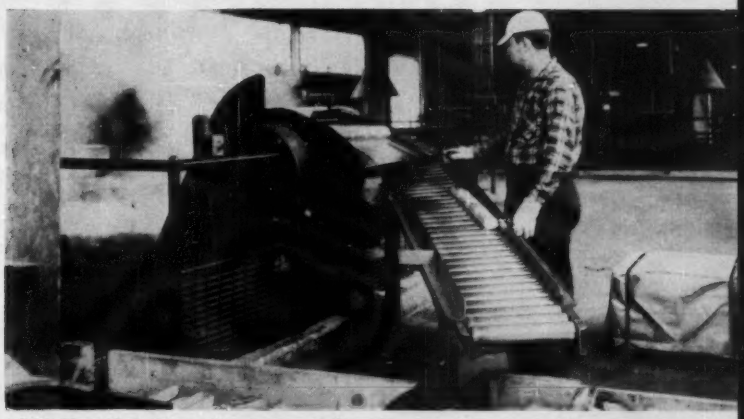


COOLING TOWERS drop temperature of cycling electrolyte to 85 F.



kimmed during melting of zinc cathode sheets.





ALLOY BARS (above) spew out of cooling section of casting machine. Below, operator ladles molten zinc into slab molds.

Most troublesome impurity is germanium which must be reduced from 10 ppm. to around 0.01 ppm. to insure smooth electrolytic deposition of the zinc.

There are four wooden precipitation tanks, each holding 50,000 gal., fitted with mechanical agitators and steam coils. Metallic copper (a precipitate from purification step in sulfide plant) and zinc dust are added to solution at 180 F., precipitating most of the germanium. A second precipitation with zinc dust, copper sulfate and arsenious oxide leaves a solution containing less than 0.5 mg. total impurities per liter.

▶ **And Electrolyze**—Cell room in the oxide plant contains 196 acid-brick-lined concrete electrolysis tanks. Each tank holds 29 silver-lead alloy anodes and 28 aluminum cathodes. Tanks are 9 ft. long and 2.5 ft. deep.

Circulating zinc electrolyte, containing 60-65 gpl. Zn and 190-200 gpl. H_2SO_4, enters cells at about 85 F. Electrolyte leaves cells at around 105 F. and is chilled in cooling towers. Total cell load is 19,500 amp. at 600 v. d.c.

Zinc plates out on the cathodes. Every 16 hours an operator withdraws cathodes from the tanks and strips off the zinc sheet (around 99.995% pure). Sheets are charged to a gas-fired reverberatory melting furnace, and molten zinc is cast into 63-lb. slabs.

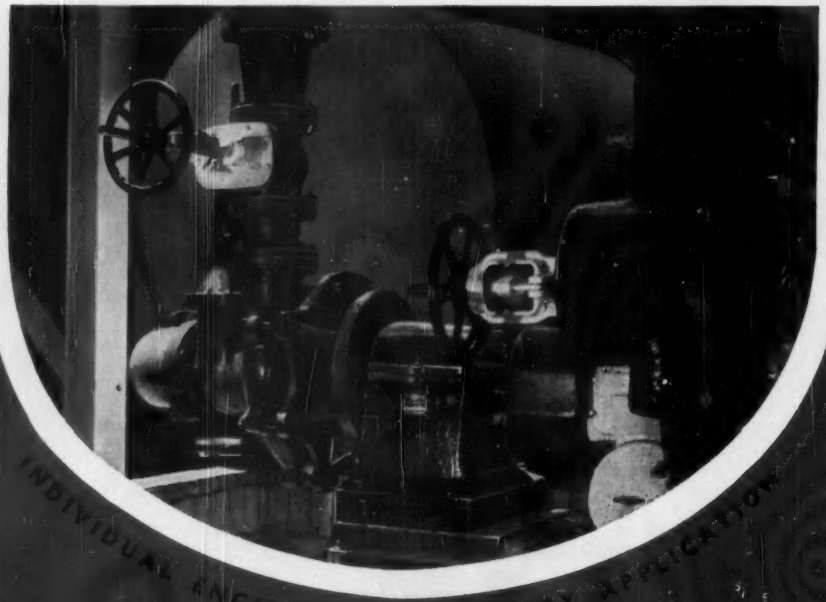
A stream of molten zinc can be diverted to the alloying furnace, where alloying metals (4% Al, up to 2% Cu, 0.04% Mg) are added and melt is cast into bars.

HOT H_2SO_4
Over the Tower Recirculating Pumps

WILFLEY
ACID PUMPS

Here is one of the toughest pumping jobs in the manufacture of Sulphuric Acid. Actual cost records prove this Wilfley pump saves production dollars. Here again Wilfley is handling highly corrosive liquids efficiently and economically without leakage or undue expense for pump maintenance. Wilfley's continuous, trouble-free performance and longer pump life reduce operating costs in *every* installation.

Wilfley Acid Pumps are available with pumping parts of the machinable alloys as well as plastic to meet all requirements.



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Texas City Refining Inc. cuts valve replacement cost 500% plus

"Craneloy 20" valves on sulphuric service outlast valves formerly used 6 to 1

Handling sulphuric acid in varying concentrations is tough service for any valve.

At this Texas City, Texas, refinery, valves used on lines from sour water strippers never lasted more than 6 months. It was a case of "install today . . . replace tomorrow."

Three years ago, "Craneloy 20" gates were selected for this service. These high-nickel, high-chromium stainless valves, with rotating split-wedge disc seating, have given trouble-free service ever since. No leakage, no galling or seizing; and always operating smoothly.

To date, "Craneloy 20" valves have outlasted the other make valves 6 to 1—better than a 500% saving in replacement and maintenance cost.

If you're having trouble with valves on sulphuric acid or similar corrosive fluids, your Crane Representative has all the information on the "Craneloy 20" line.

Bring yourself up to date on corrosion-resistant alloy valves. Send for this Crane Circular AD-2080 today.

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Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

RAYMOND ROLLER MILL

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of
RAYMOND ROLLER MILLS
on grinding
PHOSPHATE ROCK

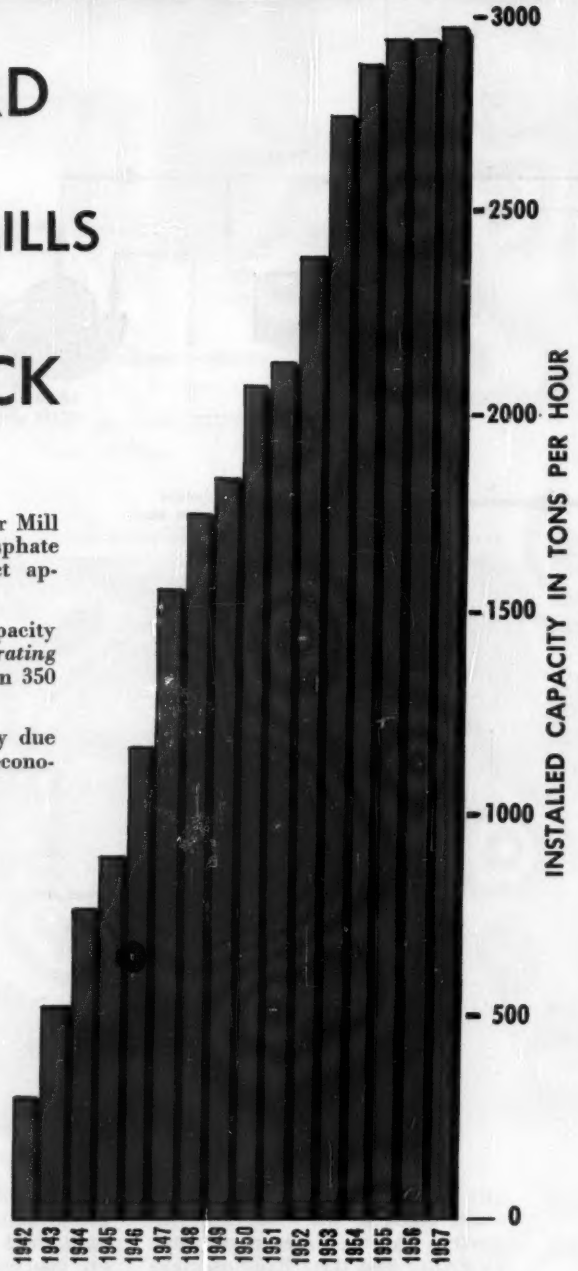
IN the past 15 years, [illegible] Raymond Roller Mill installations have gone into service, pulverizing phosphate rock for acidulation, acid manufacture and direct application.

As shown by the chart, this brings the installed capacity of Raymond Roller Mills to *nearly 3000 tons per operating hour, or in excess of 16,000,000 tons yearly,* based on 350 2-shift a day operation.

This phenomenal endorsement by industry is mainly due to the following advantages which add up to record economies year after year.

1. **Lowest initial cost, power cost, and overall operating costs.**
2. **Dependable, long service life, backed by over 70 years' experience.**
3. **Ability to handle all known deposits with a wide range of capacities available.**
4. **Automatic, dust-free operation with a very minimum of attention.**
5. **Optimum particle size distribution and ease of fineness control.**
6. **Ability to dry, grind, separate and convey in one simple operation.**
7. **Minimum space requirements and flexibility to meet plant layout.**
8. **Low maintenance.**
9. **Active research and development over the years by Raymond to further improve grinding efficiency.**
10. **Competent engineering and operating service.**

With a problem in this or a similar field, check the facts and compare. When put to test, Raymond proves best.



YEARLY GROWTH OF RAYMOND ROLLER MILLS PULVERIZING PHOSPHATE ROCK

COMBUSTION ENGINEERING, INC.

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DEC. 15, 1958

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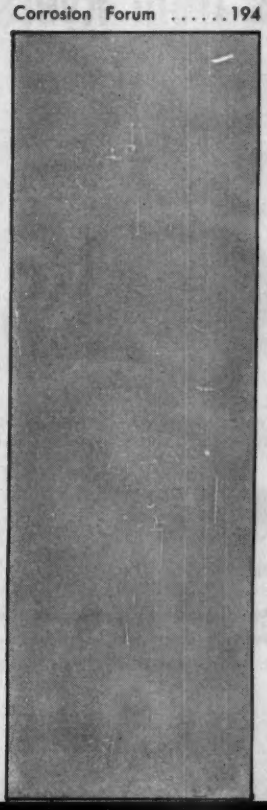

One-stop service for zinc refining and alloying..... 128

Flowsheet at American Smelting & Refining Co.'s Corpus Christi plant was recently revamped to turn out zinc die-casting alloys as well as electrolytic zinc.

Materials of construction—18th biennial report...137-176

Practical, useful information on what metals to use in high-temperature chemical and petroleum process equipment; how to avoid costly application errors. (p. 137)

Check the new listing of major manufacturers of materials of construction. This timely reference shows who-makes-what and gives product applications. (p. 148)

Inventory of literature keeps you abreast of the fast-moving materials of construction field. Use the checklist with our Reader Service Card for prompt action. (p. 171)

How deep is the ocean; how high is the sky..... 177

Flare stacks should be high enough to prevent pollution should the flame fail. But how high is high enough? This article gives you a safe basis for your design.

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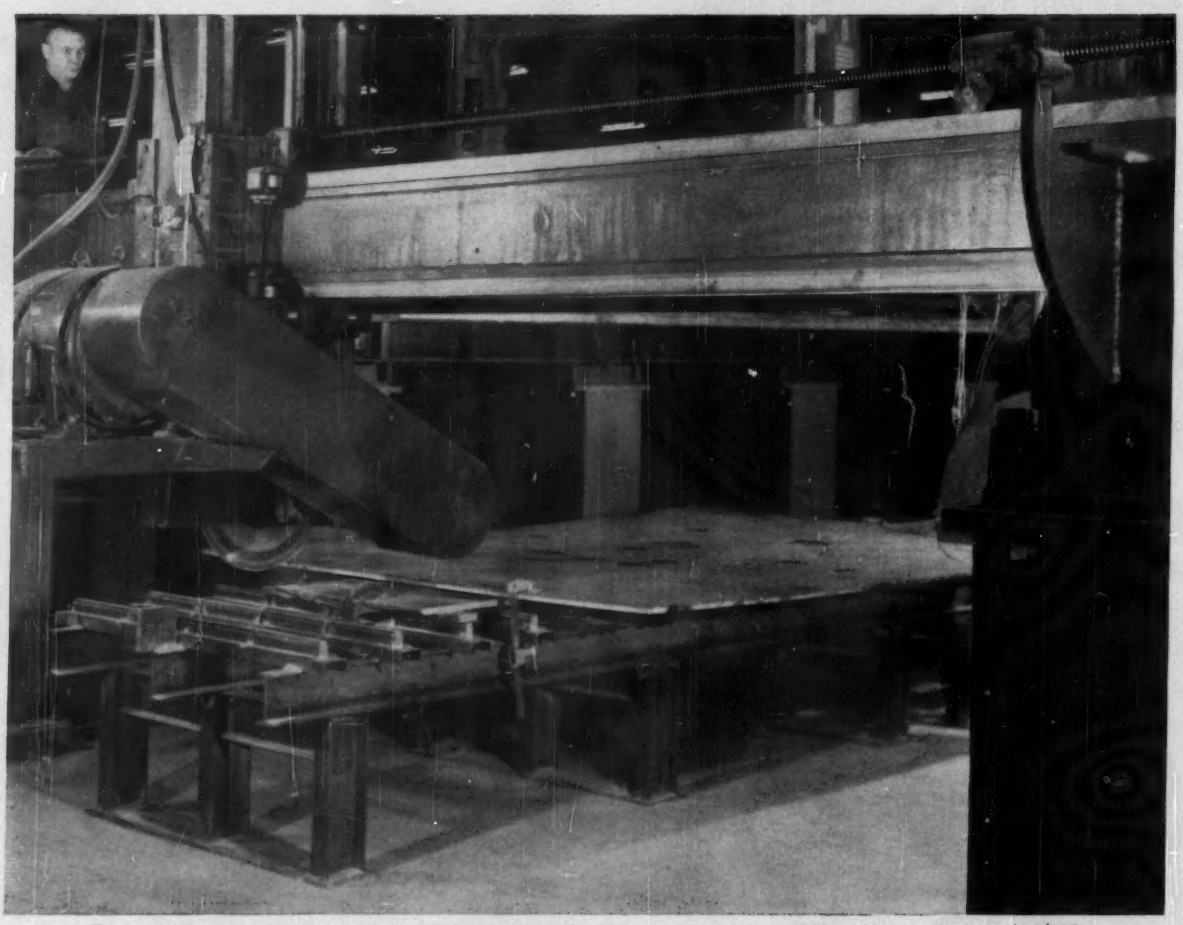

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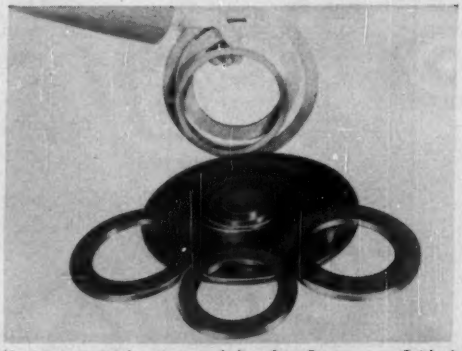

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Chemical Engineering

DECEMBER 15, 1958

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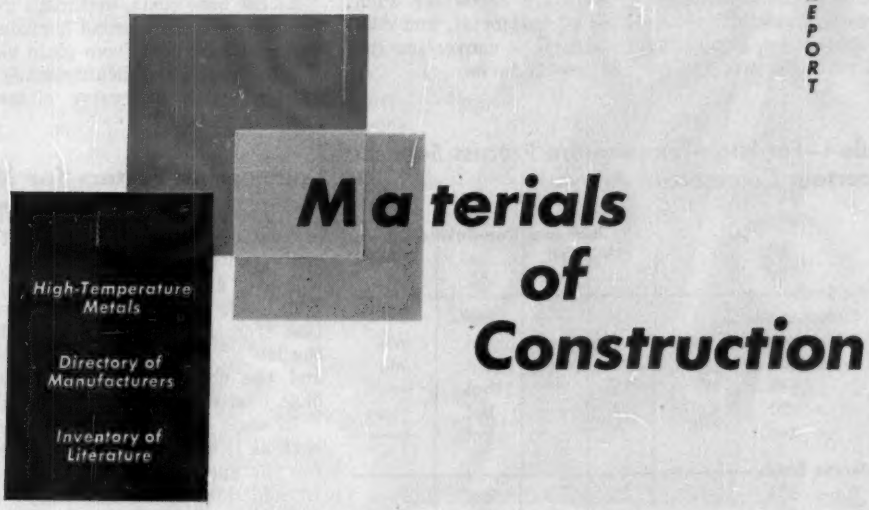


High-Temperature Metals

Principles of selection, alloys available, high-temperature behavior, by E. Skinner, International Nickel Co., New York

More and more chemical and petroleum operations involve high temperatures. The trend is definitely towards greater yields, shorter reaction times and improved efficiencies. In many cases these results are impossible without the stimulus of high process temperatures.

But such temperatures place a heavy burden on materials of construction. The metals group is no exception.

Proper metal selection is vitally important. Penalties for serious misapplication are curtailed production, lengthy shutdowns, frequent maintenance and possible loss of capital outlay.

Fortunately the growth of high-temperature technology has led to accumulation of a large amount of experience and background regarding basic principles of metal alloy selection. This information can be very helpful in avoiding costly errors if you use it to predict how a metal will act in high-temperature service.

We are now going to discuss some of these principles, list metals of interest and take up metal behavior at elevated temperatures. For our purposes "high temperature" includes the range 400-2,000 F., with emphasis on the upper limit.

Maximum Trouble-Free Hours

Successful application of metals in high-temperature service greatly depends on ap-

preciation of one point: Performance depends on properties inherent in the alloy composition and on use conditions. With an understanding of this point, there is a far better chance to achieve the objective: an alloy giving the maximum number of trouble-free operating hours per dollar invested.

In approaching the problem of high-temperature material selection, there are important factors to recognize. In one group, are what may be loosely defined as economic factors. Here we encounter such terms as availability, base cost of the metal, and cost of fabricating, machining, or otherwise converting the raw material into the desired useful form.

Table I—For High-Temperature Process Service: Important Commercial Alloys

	Nominal Composition			
	Cr	Ni	Fe	Other
Ferritic Steels				
Carbon steel	—	—	bal.	—
2¼ chrome	2¼	—	bal.	Mo
Type: 502	5	—	bal.	Mo
410	12	—	bal.	—
430	16	—	bal.	—
446	27	—	bal.	—
Austenitic Steels				
Type: 304	18	8	bal.	—
321	18	10	bal.	Ti
347	18	11	bal.	Cb
316	18	12	bal.	Mo
309	24	12	bal.	—
310	25	20	bal.	—
330	15	35	bal.	—
Nickel-Base Alloys				
Nickel	—	bal.	—	
Incoloy	21	32	bal.	
Hastelloy B	—	bal.	6	Mo
Hastelloy C	16	bal.	6	W, Mo
60/15	15	bal.	25	
Inconel	15	bal.	7	
80/20	20	bal.	—	
Hastelloy X	22	bal.	19	Co, Mo
Multimet	21	20	bal.	Co
Cast Irons				
Ductile iron	—	—	bal.	C, Si, Mg
Ni-Resist, D-2	2	20	bal.	Si, C
Ni-Resist, D-4	5	30	bal.	Si, C
Cast Stainless (ACI Types)				
HC	28	4	bal.	
HF	21	11	bal.	
HH	26	12	bal.	
HK	26	20	bal.	
HT	15	35	bal.	
HW	12	bal.	28	
Super Alloys				
Inconel X	15	bal.	7	Ti, Al, Cb
A 286	15	25	bal.	Mo, Ti
Stellite 25	20	10	Co-base	W

Among these economic factors, availability (or rather, lack of availability) may present a very real and serious problem. The alloy may be normally scarce or, unavailable in a desired form. For example, you might wish small light-wall seamless tubing, or perhaps fine wire, of a composition impractical or uneconomical for a mill to produce in wrought form. Or, conversely, the alloy desired might, for basic metallurgical reasons, be impossible to supply as a casting.

As for base costs, materials giving satisfactory performance within a broad horizon of temperatures, may range in base cost from plain carbon steel up to some of the special difficultly-made alloys, highly compounded with expensive elements, or even to the precious metals.

Engineering Factors for Metal Selection

In a second group are the specific engineering factors of heat-resistant materials, with which we are especially concerned. Table I lists a number of common wrought and cast alloys used at high temperature. Note: this listing covers a wide spectrum of composition from mild steel and low-alloy cast iron, through the low-alloy steels, stainless steels, chromium-ferritic and the chromium-nickel austenitic types, to nickel base heat-resistant alloys and ultimately pure nickel.

In some cases there are minor additions of elements such as titanium, columbium, molybdenum, and silicon for the special benefits these constituents contribute. In addition, there are alloys of nickel-molybdenum, nickel-copper, as well as cobalt-base alloys that find special application.

It's clear there is a broad variation in properties in the variety of alloy compositions shown in Table I. For clarity let's subdivide these into physical, mechanical or chemical properties.

Physical Properties Are Vital

Physical properties are those basic to and inherent in individual alloy compositions and are more or less insensitive to processing variables. They include characteristics such as: crystal structure, density, thermal conductivity, electrical resistivity, thermal expansivity, structural stability, melting range and vapor pressure.

Thermal conductivity is a property of some importance. Pure metals have the highest conductivity. Thermal conductivity is reduced but still fair in the low-alloy steels and cast irons. However, with chromium and chromium-nickel stainless steels where sufficient alloy content is present for strength or oxidation resistance, thermal conductivity falls to a low value and is relatively insensitive to large differences in base composition.

Of usually greater relative importance in this group of properties is expansivity (Fig. 1).

A surprisingly large number of metal failures at elevated temperatures are the result of excessive thermal stresses originating from constraint of the metal during heating or cooling. Such constraint in the case of hindered contraction can cause rupturing.

Another type of thermal stress results from temper-

ature differences, either between two points on a common surface of the metal (a hot spot on a baffle) or between two opposing metal surfaces (the hot outside and cold inside of a fired vessel). Thermal stresses may easily build up to such a high level that fairly rapid dissipation occurs by plastic flow or creep. On cooling these stresses are reversed. Under such conditions, if the temperature is cycled as in a batch operation, repeated plastic yielding and stress reversal may eventually lead to cracking and failure by thermal fatigue.

Most Important: Structural Stability

Perhaps the most important physical property is alloy structural stability. This means freedom from formation of new phases or drastic re-arrangement of those originally present within the metal structure as a result of thermal experience. Such changes may have a detrimental effect upon strength or corrosion resistance, or both.

Structural instability may manifest itself in the well-known sensitivity to intergranular corrosion. Certain stainless steels as a result of grain boundary precipitation of carbide phases become depleted in chromium and lose their corrosion resistance.

Other iron-base heat resistant alloys may become embrittled by formation of the sigma phase after lengthy periods of heating within a critical temperature range.[1] Similarly, carbon and carbon-molybdenum steel, especially in weld adjacent areas may become brittle by the formation of graphite after prolonged heating.[2] Fortunately, for each of these examples of structural instability specific remedies are available: an extra low-carbon content or stabilization with titanium or columbium in the case of sensitized stainless; increased carbon, nitrogen or nickel content to prevent the formation of sigma; and a small addition of chromium, about 1%, to prevent graphitization.

Mechanical Properties Aid Proper Choice

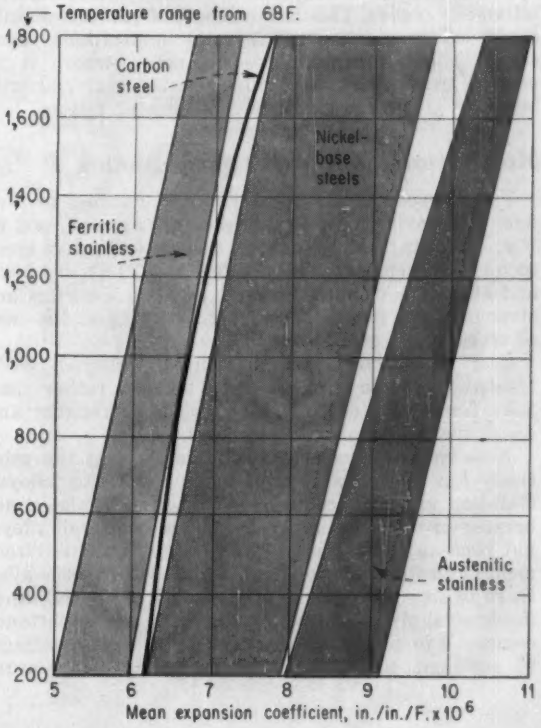
A second group of properties, of very wide interest, are those involving creep, rupture and short-time strengths, various forms of ductility, as well as resistance to impact and fatigue stresses. All these are grouped under mechanical properties.

One commonly used criteria of high temperature load-carrying ability is creep strength. This relates the initially applied stress to the rate of plastic flow or elongation of the metal and is usually determined at constant temperature. Since creep is a rate process influenced by stress, temperature, and time, its definition in engineering terms associates a stress at a temperature that results in more or less constant and specific rates of extension. Generally, these rates are 1% in 10,000 hr. or 1% in 100,000 hr. Such data are reported more properly as 0.1% and 0.01% per 1,000 hr. respectively, to avoid the frequently erroneous implication that the rate may be constant for the full duration.

Creep Strength Influenced by Composition

From Fig. 2, which shows a strength comparison of a number of alloys as a function of temperature, it

How Temperature Affects Metal Expansion Fig. 1



is apparent that creep strength is considerably influenced by alloy composition. Ferritic alloys are weaker than austenitic compositions, but in both groups the chief benefit is contributed not by chromium but by molybdenum, as typified by 2¼ Cr and Types 502 and 316. Austenitic castings are significantly stronger at high temperatures than their wrought counterparts. This is not surprising considering that this class of materials is not intended to have a high degree of hot workability. Improvements possible by judicious alloying are reflected in considerably higher creep strengths of wrought age-hardenable nickel-base Inconel X, cobalt-base Stellite 25, and iron-base A286.

Stress Rupture Data Important for Vessels

Creep strength associates initial stress with rate of extension and thus may be of prime importance, for example, in maintaining a definite clearance for a rotating part, such as turbine blades. But, it gives no indication of the relation between stress and time to produce rupture, which is of greater interest to the designer of stationary equipment such as vessels and furnaces.

Stress-rupture tests provide this type of data. They are of great value for the major proportion of high-temperature metal applications. Such stress data supply the designer with a base line of stress above which premature failure is certain to result, but also gives

information on the amount of elongation the metal will sustain over a long period of time before failure ultimately occurs. This latter aspect of residual ductility at failure is important in many applications, especially in hot high-pressure equipment—where it is gratifying to know the constructional material will bulge or give some other forewarning of failure.

Molybdenum Important Strengthener

Values reported in the literature for stress to produce rupture in 10,000 hr. are shown for comparison in Fig. 3. Again, molybdenum is the most effective common strengthener among both ferritic (2¼ Cr and 502) and austenitic compositions (Type 316). Castings are stronger than forged alloys in rupture as in the case of creep.

Cast irons, both plain and highly alloyed, when treated to obtain graphite in a nodular rather than flake form have usefully high rupture-strengths and ductilities among iron-base alloys.

Note that as temperatures increase, first the relatively low alloy steels, then the more highly alloyed stainless grades become less attractive. This is not because of strength, which is low for nearly all alloys, but because of the destructive action of the environment, namely oxidation and scaling. For each alloy there is a temperature limit where strength and other mechanical properties become of secondary importance compared to resistance to attack by the surroundings. If sufficient chromium is present, this temperature limit may be extended in iron-base and nickel-base alloys to temperatures in the vicinity of 2,000 F. and above.

Chemical Properties Outweigh Physical

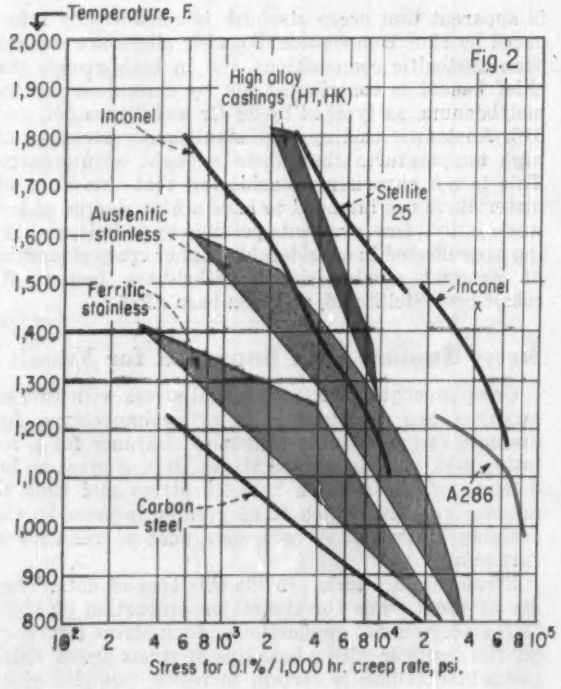
Temperatures of a high order lead inevitably to the third and perhaps most important phase of this discussion of metals for high-temperature chemical processing. Namely, consideration of chemical properties in terms of a particular alloy's ability to resist destruction by any of a number of hot environments. This facet of high-temperature corrosion resistance considerably outweighs any advantages of higher strength in a less resistant alloy.

Of the various forms of high-temperature corrosion likely to be encountered in chemical processing, attack by gaseous environments is by far the most common. In this group oxidation or scaling has received the greatest amount of attention.

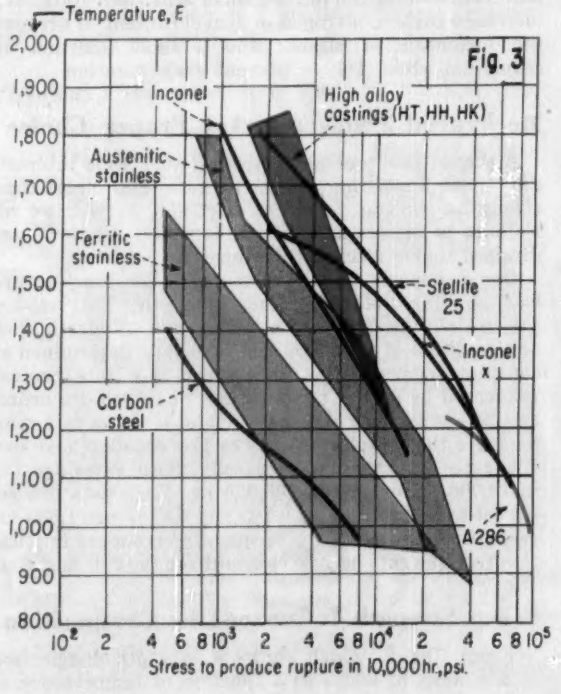
How to Combat Oxidation and Scaling

Any metal or alloy exposed at high temperatures to air or to combustion products of hydrocarbon fuels, to steam or to many other compound gases containing oxygen may be susceptible to a corrosion process that converts the surface material to an oxide. All common heat-resisting alloys not only form oxides, but do so rapidly on initial exposure to an oxidizing environment. Whether resistance to continued rapid oxidation

Creep: Important High-Temp. Property



Watch Rupture Properties as Temp. Goes Up



is exhibited for longer exposures depends upon whether the oxide provides an effective barrier separating the gas and underlying metal. If this desirable condition results, it is theoretically possible for the corrosion process to be slowed down to a very low rate.

Chemical nature of the oxide is of some importance in influencing this process, but physical characteristics, such as adherence, expansivity, specific volume, and elasticity, are of greater practical moment.

Laboratory studies show, with many alloys, the oxide may offer good protection when of limited thickness, but as the thickness increases with time, there is usually a tendency for fissuring or cracking. A break in the film exposes fresh metal and permits the process to take place at the initial high rate.

Transverse film cracking, combined with lateral splits or fissures at the scale-metal interface, results in detachment and loss of a fragment of oxide and represents scaling in the common sense. Clearly this process is a serious matter, since it represents a loss in section. If it occurs on a load-carrying or pressure-retaining member, it is inevitable that continual wastage leads to failure.

Chromium Gives Tight Film

Mild steel, the universal construction material against which all alloys must be compared on a cost/performance basis, is seldom used above 950-1,000 F. because of excessive scaling rates.

Higher temperatures require chromium, which diffuses rapidly and accumulates at the surface of the steel, providing a tightly adherent oxide film that materially retards the oxidation process. Amount of chromium required to supply practical scaling protection increases with temperature.

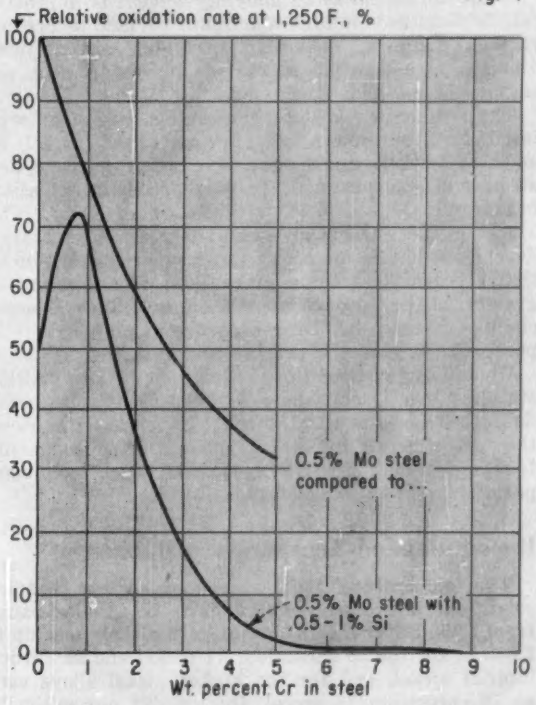
Extensive laboratory studies, confirmed by practical experience, indicate some degree of improvement over base steel can be noted at the 2-3% chromium level. The increase is more impressive for the widely used 4-6% chromium analysis, Type 502, which is considered an acceptable material for 1,150-1,175 F. service. Progressive increases in chromium to 9 and 12% boosts the temperature limit to 1,300-1,400 F., while with 14-18% chromium, a recommended limit is 1,400-1,500 F., and at 27% chromium, the limit is extended to 2,000 F.

Also Consider Silicon and Aluminum

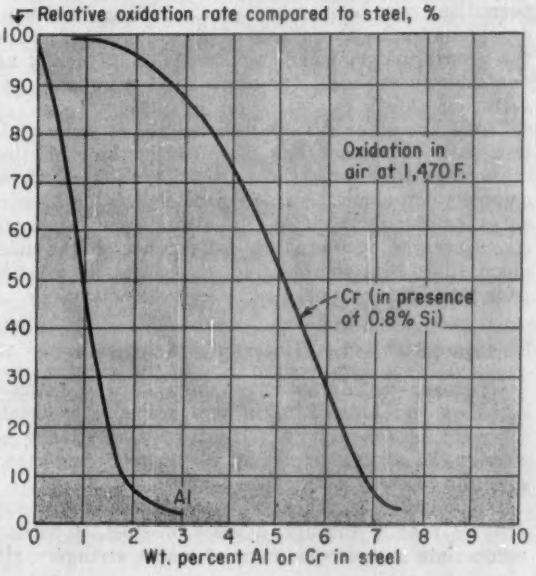
Another element useful in imparting oxidation resistance to steel (complementing the beneficial effects of chromium) is silicon. In the lower chromium ranges, silicon in amounts of about 0.75-2% is more effective than chromium on a weight-percent basis. The influence of 1% silicon in improving the oxidation rate of steels having variable chromium contents is shown in Fig. 4.[8]

Aluminum also tends to improve resistance of iron to oxidation as well as to sulfidation. But it cannot be used as an alloying element to substitute for chromium because the amount required interferes both with workability and high-temperature strength properties of steel. A comparison of the effect of aluminum and

Silicon Reduces Corrosion of Steel Fig. 4



How Cr and Al Reduce Steel Oxidation Fig. 5



chromium on oxidation rates of steel is given in Fig. 5.[3]

While aluminum as an alloying element is impractical, development of high-aluminum surface layers by various methods, including spraying, cementation, dipping, is a feasible means of improving heat resistance of low-alloy steels.

The well-known austenitic stainless steels containing 15-25% chromium and upwards of 8% nickel, in addition to their useful corrosion resisting properties at normal temperatures, feature excellent oxidation behavior.

As in the chromium steels, degree of resistance depends on chromium content, but experience has been that the benefit from a given level of chromium is greater as the nickel content increases. This is especially so in cases involving exposure to very high temperatures or to cyclic heating and cooling.

Under cyclic conditions of heating, lower-nickel stainless steels may show a tendency toward oxide flaking. This is due to the effect of larger stresses at the oxide-metal interface—larger than commonly found in higher nickel compositions which have comparatively lower expansivities.

Recommended Temperature Ranges

The temperature limits recommended[4] for constant conditions if excessive scaling is to be avoided range from 1,650 F. for the 18 chromium/8 nickel types up to 2,000 F. for the 25 chromium/12 nickel and 25 chromium/20 nickel, and for the higher nickel alloys such as 15 chromium/35 nickel, Incoloy (21 chromium/34 nickel), and Inconel (15 chromium/78 nickel). On the other hand, these temperature limits would be modified downward, perhaps by as much as 100 F. and more in the case of high-iron alloys, if cyclic heating and cooling were being considered.

Where unexpected failures of furnace tubes and other fired components have occurred, these are often the result of an upset in operating conditions, usually permitting over-temperature excursions, rather than a deficiency in the alloy itself. This assumes, of course, the proper material had been installed originally and due allowances made for extra heat resistance as a factor of safety.

There are other cases where failure of some stainless steel equipment has been caused by conditions other than high-temperature service, such as stress-corrosion cracking from chloride-containing condensates during down time. In either case, when the circumstances surrounding failure are fully understood, there is no justification to condemn the alloy for poor performance under non-design conditions.

Metals to Use in Hydrogen Atmosphere

Hydrogen-containing atmospheres are common in chemical and petrochemical processing. At elevated temperatures, especially at high pressures, they can have any of several important effects requiring care in selection of constructional materials.

One form of trouble: while the gas in atomic form diffuses readily through a piece of steel, it tends to accumulate in molecular form at seams, stringers, rifts and other faults within the metal. This produces high local pressures that can result either in blistering or in extreme cases, actual rupture. Such behavior is related to the dirtiness of the metal. Metallurgical products which inherently have this fault—for example rimmed steel—are to be avoided where hydrogen is handled.[5]

Another type of distress which certain low-alloy steels can suffer is the reaction of the inward diffusing hydrogen with iron carbide. This forms methane—a gas insoluble in the metal and again capable of very high and even disruptive pressures. Solution to this problem: have the carbon firmly fixed as a stable carbide not readily reduced by hot hydrogen. Alloying additions such as chromium, tungsten, vanadium, titanium and columbium are effective in this respect. Austenitic stainless steels by virtue of their high chromium contents are usefully hydrogen resistant. But, a tendency toward intergranular embrittlement at about 1,200 F. indicates stabilized grades of 18/8 are preferred over unstabilized.

Use This Guide

One of the best guides as to amount of alloying required for resistance to hydrogen attack at different temperatures and pressures is one compiled by Nelson[6] from a large number of well documented cases of success and failure. This curve has been revised periodically until in its present form (Fig. 6) it can be used by design engineers with considerable confidence.

What About Nitrogen Attack?

Atmospheres containing nitrogen and gaseous nitrogen compounds require a certain amount of caution in choosing alloys.

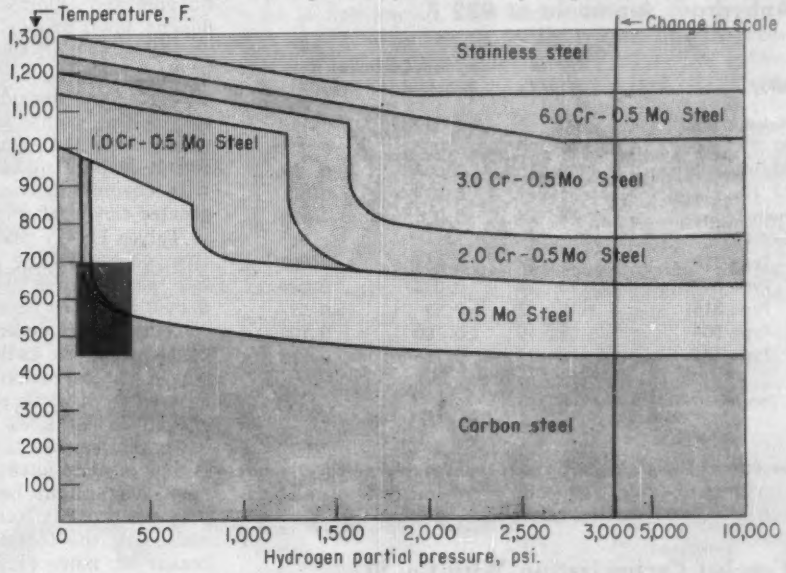
Ammonia, the most important gas, when freshly dissociated into nitrogen atoms can cause severe nitriding, even at the relatively low temperature of 932 F., as shown in the corrosion data[7] of Table II.

Penetrating nitrogen atoms react with chromium, iron, aluminum, titanium and other alloying ingredients forming hard, brittle nitride phases that, because of the volume change accompanying their formation, frequently lead to a cracked and blistered surface. High-nickel alloys because of their reluctance to form nitrides, are preferred materials in handling ammonia and its dissociation products. There are cases where nickel electrodeposited on low-alloy steels is said to have imparted useful resistance in ammonia converter components.

Molecular Nitrogen Is Stable

When nitrogen is in molecular form, the gas is fairly stable and has little tendency to dissociate at the metal surface. The tendency for attack to occur in molecular nitrogen is increased at high temperatures (on the order of 1,600-2,000 F.) and occasionally furnace parts or stress rupture specimens exposed to air for very long periods show evidence of some nitriding, although not usually sufficient to cause failure. In fact, nitride formation (as well as internal oxidation) during stress

Where to Use Steels in High-Temperature Hydrogen Service Fig. 6



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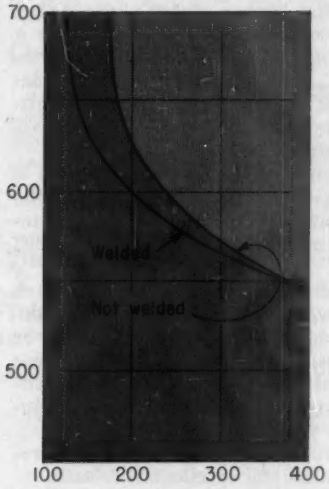

rupture testing of heat resistant alloys in air has been found responsible for substantial strengthening.[8]

In the case of heat-resisting alloys, simultaneous oxidation of the surface results in a tenacious oxide film which behaves as a barrier and reduces the extent of nitriding (Table II). Because of this, oxides of nitrogen, such as those resulting from the dissociation of nitric acid,[9] appear to have no serious effects on heat-resisting alloys beyond normal oxidation.

Carburization: Not True Corrosion?

Another type of high-temperature reaction that can influence performance of heat-resisting alloys is carburization, a process which involves absorption of carbon by the metal as a consequence of heating in a carbonaceous atmosphere. This is not true corrosion in the usual sense that metal loss occurs; nevertheless, it may have profound influence upon the properties of heat-resisting alloys. It deserves consideration in the selection of chemical and petrochemical materials.

The initial stage of carburization involves adsorption of carbon—mainly from a gas, occasionally from a liquid, and only rarely from a solid—upon the metal surface. If the temperature is high enough, carbon diffuses into the alloy and causes precipitation of stable carbides of chromium and, to a lesser extent, iron.

Nickel forms a carbide of only limited thermal stability and the principal result of carburization is to remove chromium from solid solution. Formation of hard and brittle carbide phases within the structure has the general effect of raising the hot strength of the alloy and at the same time causing a great reduction in ductility.

Embrittling effect of carburization is usually most severe when conditions have been favorable to the formation of a nearly continuous network of carbides in the grain boundaries. It's least severe when temperature fluctuations promote coalescence of the carbide phase.

Carbon absorption may also have an effect upon metal chemical properties, depending on the degree to which the original chromium content is immobilized. Behavior of an alloy in resisting sulfur attack or oxidation—both of which are specific to chromium content—can be adversely affected by carburization.

Carbon Combines With Ti, Cd

In addition to reacting with chromium, the inward diffusing carbon, of course, combines with titanium and columbium, the carbide stabilizing elements employed in stainless steels. Carbide stabilization, or the use of extra low-carbon grades, is not necessary to insure high-temperature corrosion resistance, since the well-known chromium carbide precipitation at the grain boundaries, is only of importance under conditions favoring the existence of an electrolyte. However, these conditions are encountered during shutdown periods. Corrosive condensates may be present in contact with a stainless steel sensitized by the precipitation of carbon during cooling from operating temperatures. While the usual means of combatting this type of attack is to use either extra low-carbon alloys

Table II—How Ni-Cr-Fe Alloys Stand Up to Anhydrous Ammonia at 932 F.

Alloy	Content Ni	Cr	Maximum Corrosion Rate, lpy. Polished	Oxidized
Nickel	100	0	0.079	0.098
80/20	79	20	0.007	0.005
60/15	59	15	0.007	0.007
38/18	35	19	0.017	0.011
Inconel	78	14	0.006	0.010
Stainless				
Type 310	21	24	0.054	0.007
Type 309	13	24	0.095	0.049
Type 316	12	17	>0.52	>0.52
Type 304	9	19	0.100	0.102
Type 446	0	29	0.165	0.173

Data based on 1,540 hr. exposure.

or one of the stabilized grades, obviously neither would continue to exhibit aqueous corrosion resistance if extensive carburization takes place during service.

Combat Carburization With Cr, Si

As far as the effect of alloy composition on carburization is concerned, field experience and laboratory examination of field exposed test pieces indicate resistance depends importantly upon chromium.

In the ferritic steels under fairly severe conditions, resistance is poor unless the chromium content is high. The amount of carbon absorbed by Type 430 is much greater than Type 446 under identical conditions of exposure. Chromium slows the carbon diffusion process.

Better resistance is found in austenitic steels, and again chromium is the important element, with its effectiveness enhanced at higher nickel contents. As an example, in one test the amount of carbon absorbed is much less for Type 310 than for Type 309 or 304.

Among auxiliary alloying elements, up to about 2.5% silicon is most effective in preventing carbon absorption, especially in the 18/8 and 25/20 base compositions where such modifications are known as Type 302B and 314, respectively. Strong ferrite forming tendencies of silicon may lead to a troublesome type of embrittlement due to the sigma phase.

In furnace tubes or vessels handling hydrocarbon compounds, one of the commonest forms of carburization occurs during decoking. Here a deposit of solid carbon is allowed to burn improperly in a more or less uncontrolled fashion. These conditions can lead to very high local temperatures which, aside from the likelihood of producing bulges from overheating, also introduce the hazard of carbon absorption and reduction of ductility in the location of the bulge.[9]

Halogen Attack at High Temperatures

Halogens or halide-containing atmospheres represent environments highly corrosive to common materials of construction at elevated temperatures.

Resistance of metals to attack in atmospheres of fluorine and chlorine and their hydrogen compounds depend upon properties of the metal halides formed on the surface of the three main alloying components of heat-resisting metals—iron, chromium and nickel. Chlorides and fluorides of the first two have relatively low melting points and high vapor pressures as compared with the corresponding compounds of nickel. Result is pure nickel and higher nickel alloys either with chromium, iron, copper or molybdenum have a greater temperature range of usefulness[11, 12] as shown in Tables III, IV and V. This superiority is only relative; even with the best engineering materials, limiting temperatures are low and corrosion rates as reflected in inches penetration per month are high.

Temperature dependency of the corrosion process is considerable as indicated in one set of test results where the corrosion rate for nickel in fluorine[13] increased from 4 mils per month at 1,022 F. to 50 at 1,202 F. and 353 at 1,382 F.

Observe caution in using steel, copper and aluminum. Although they have low resistance to attack by chlorine, they might be considered economical at lower temperatures. It has been reported[14] that with these materials, the threshhold temperature for rapid corrosion or, more properly, exothermic reaction, is influenced by gas-stream velocity.

There are cases where equipment for high-temperature halogenation has used the excellent corrosion resistance of platinum-clad nickel-base alloys. Despite high initial cost, this choice represents a favorable economy in terms of increased production and decreased equipment maintenance.

Severe Sulfur Corrosion

One of the commonest forms of high-temperature corrosion, and of even greater importance than oxidation and scaling, is resistance of alloys to attack in sulfur-containing environments. Not only in chemical processing, but also in many applications involving use of various types of fuel, the need for obtaining materials having satisfactory resistance at high temperatures usually dominates all other factors considered in the selection of alloys.

Generally speaking, sulfidation resistance directs the choice of alloy composition, even to the point of compromising properties of strength, fabricability, or resistance to other types of corrosion.

In many respects, the reaction of a metal surface with sulfur resembles the oxidation process. Sulfidic scales form which, under some conditions, may even provide a protective barrier. But, the physical and chemical characteristics are a good deal more sensitive to the temperature of formation, concentration of the corrodent, and especially with respect to the form that sulfur exists in the environment. For example, the type of attack on heat-resisting steels may be tremendously dependent upon whether sulfur is in elemental form, as H_2S in a product stream or as SO_2 in the oxidizing combustion products of a sulfur-containing fuel. Nature and extent of attack in each case may be quite different, as well as the effect of alloy composition, in combatting the particular type of attack.

In general, one of the main differences between oxidation and sulfidation is sulfidic scales more often show poor adherence characteristics which leads to exfoliation and the creation of problems of metal wastage or fouling of other equipment by scale debris.

Another difference is the common trait of sulfide phases having comparatively low melting temperatures and, in addition, forming even lower melting mixtures or eutectics with most constructional metals.

Chromium Most Important

Chromium is the most valuable element in imparting resistance to steel against most forms of sulfur attack. Similarly, silicon and aluminum, among minor alloying elements, afford some protection, although with aluminum the high percentage required is more conveniently secured by surface enrichment.

As is well known, pure nickel, in contrast to pure iron or chromium, reacts avidly with sulfur in practically any form to produce low-melting sulfur eutectics situated in the grain boundaries and, therefore, potent in embrittling effect. This tendency is still evident in the intermediate nickel-containing chromium steels and advises against their selection for handling large sulfur concentrations, especially as H_2S, and at higher temperatures. On the other hand, there are a number of applications, especially in petroleum refining, where 18/8 austenitic steels are preferable over straight chromium grades for resisting sulfide scaling attack of hydrocarbon-H_2S-H_2 mixtures at intermediate temperature and high pressures.[35, 38]

What Metals to Use Against High-Temperature Halogen Corrodents

Table III—Fluorine[a]

	Approximate Temp., F., for Inches Penetration/Month of:					Upper Temp. Limit for Continuous Service, F.
	0.0025	0.005	0.01	0.05	0.10	
Nickel	875	975	1,050	1,225	1,300	——
Monel	900	950	1,025	1,150	1,200	——
Inconel	——	——	550	850	975	——
Type 310	——	——	525	600	630	——
Type 309 + Cb	——	——	425	550	575	——
Type 347	——	——	——	350	450	——
Type 430	450	500	550	625	675	——
Iron	500	575	650	800	875	——

Table IV—Dry Chlorine

Nickel	950	1,000	1,100	1,200	1,250	1,000
Inconel	950	1,000	1,050	1,200	1,250	1,000
Hastelloy B	950	1,000	1,100	1,200	——	1,000
Hastelloy C	900	1,000	1,050	1,200	——	950
Magnesium	850	900	950	1,000	1,050	850
Monel	750	850	900	1,000	1,000	800
Type 316	600	650	750	850	900	650
Type 304	550	600	650	750	850	600
Platinum	900	950	1,000	1,050	1,050	500
Carbon steel	250	350	400	450	450[b]	400
Aluminum	250	300	300	350	350[c]	250
Gold	250	300	350	400	400	——

Table V—Dry Hydrogen Chloride

Platinum	2,300	——	——	——	——	2,200
Gold	1,800	——	——	——	——	1,600
Nickel	850	950	1,050	1,250	1,300	950
Inconel	800	900	1,000	1,250	1,350	900
Hastelloy B	700	800	900	1,200	1,300	850
Hastelloy C	700	800	900	1,150	1,250	850
Type 316	700	700	900	1,100	1,200	800
Type 309 + Cb	650	750	850	1,050	1,150	800
Type 304	650	750	850	1,100	1,200	750
Carbon steel	500	600	750	1,050	1,150	500
Monel	450	500	660	900	1,050	450

a.) Contains oxygen as an impurity, b.) Ignites at 450–500 F., c.) Ignites at 400–450 F.

In contrast with the purely reducing conditions obtained for hydrogen-H_2S mixtures, burning of sulfur-containing fuels results in simultaneous formation of an oxide layer on the metal surface. This is reasonably effective in slowing down sulfur absorption. Presence of SO_2 in an otherwise oxidizing environment tends to accelerate the rate of oxidation. Often SO_3 interferes with the adherence of a protective oxide. Again, chromium is one of the most useful elements in providing corrosion resistance. Similarly, both aluminum and silicon, the former as a surface coating, provide useful resistance by contributing to the stability and protectiveness of the oxide on the base metal.

Since fired vessels and tubular heaters are generally at lower temperatures because of a contained product, the really arduous conditions are those encountered by tube supports and spacers which may achieve combustion chamber temperatures. Under such conditions, alloys used require chromium contents in the range of 25-30%, with nickel frequently from 8-20%, depending upon severity of the conditions. Two common cast analyses used for furnace supports are the HH (25 Cr/12Ni) and the HD (28 Cr/8 Ni).

How to Handle Fused Salts

A number of economically significant chemicals consisting of hydroxides, chlorides and fluorides, carbonates, nitrates, cyanides, and others are handled in the molten state.

Most of the important compounds incorporate the alkali metals, sodium and potassium. These elements in original form may not be very corrosive. As oxidized decomposition products they cause a very substantial increase in the rate of attack. For example, fused sodium chloride is a fairly stable compound essentially "neutral" with virtually no corrosion occurring on the common engineering alloys. Baths consisting of fused mixtures of sodium chloride and potassium chloride are used for neutral heat treatment of steel because the salt is neither carburizing nor decarburizing and the original composition of the steel can be maintained. However, if the bath surface is exposed to normal moisture-containing air for any length of time, some of the salt decomposes and forms alkali metal oxides. These oxides behave as an effective flux and they react with the oxides of chromium and iron on the surface of heat-resistant alloys producing salt-soluble compounds, such as chromates and ferrites.[17]

At lower temperatures where normal oxidation rates are not appreciable, pure nickel and high-nickel alloys, such as Inconel, are resistant to alkali hydroxides, halides, nitrates, carbonates, and other compounds which may decompose or react with air to acquire an oxide content.

If temperatures are sufficiently high, the rate of attack may be extremely serious. Caustic fusions to dissolve mineral oxides, for example, at temperatures in the range of 1,400-1,500 F. give high rates of attack on any constructional alloy. To conduct the process in this temperature range is considered uneconomical.

Fluorides have a powerful fluxing action on metal oxides and under oxidizing conditions, such as an air environment, are a most aggressive type of corrodent. Traces of welding slag or brazing flux, both usually containing alkali fluorides, should be carefully removed from an alloy surface, preferably by sand blasting, if the service temperature is likely to be high enough to cause these compounds to become molten.

Molten Metals: Recommended Materials

The high-temperature corrosion problem becomes much more complex when you are dealing with molten metals.[18, 19, 20] Especially when used as heat exchange fluids (Table VI), the nickel-base alloys are generally inferior to the iron-base group in resisting corrosion by all molten metals because of the greater solubility of nickel. This is true for the white metals, aluminum, magnesium, tin, zinc, lead, antimony, and others. Nickel-containing alloys, however, are resistant against molten sodium and potassium.

Residual Oil Ash Corrosion

Some plants situated along the seacoast use certain imported residual oils for fuel. They have encountered a troublesome form of corrosion when the heavy residuals are used in refinery heating services. The attack, which is unusually severe on tube supports, spacers, and baffles operating at higher temperatures, is frequently found on the furnace tubes themselves as well

Table VI—Some Materials to Use Against Liquid Metals

	Hg, M. P. −36F.	Na, K, M. P. 10–208F.	Sn, M. P. 448F.	Bi, M. P. 520F.	Pb, M. P. 621F.	Li, M. P. 367F.	Cd, M. P. 610F.	Zn, M. P. 787F.	Mg, M. P. 1,204F.	Al, M. P. 1,220F.
Pure Fe, steel	OK	OK	Lim.	OK	OK	OK	OK	Lim.	OK	NG
Cast iron	—	Lim.	Lim.	—	OK	—	OK	Lim.	OK	NG
2–20 Cr steels	OK	OK	—	—	OK	OK	Lim.	Lim.	OK	—
Stainless steels	NG	OK	Lim.	—	NG	OK	NG	NG	NG	NG
Nickel	NG	OK	NG	NG	NG	Lim.	NG	NG	NG	NG
Monel	NG	OK	NG	NG	NG	NG	NG	NG	NG	NG
Inconel	Lim.	OK	NG	NG	Lim.	Lim.	NG	NG	NG	NG
Pt, Au, Ag	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Mo	OK	OK	—	OK	OK	OK	—	—	OK	—

as in related high-temperature applications, such as steam raising and power generation.

Such corrosion is caused by contact of a metal surface with fly ash or residues from combustion products of the oil which, having a relatively low fusion range, can destroy the metal's normally protective oxide. Ash constitutents contributing to the attack are mainly vanadium, which originally exists in the oil as an asphaltic compound; sulfur, also present in organic form and salt from underground brine or from sea water transshipments. In the deposited ash these elements form compounds usually identified as V_2O_5 and Na_2SO_4,[21] which in mixtures of certain proportions, can have fusion temperatures as low as 1,145 F.

Temperature Is Important Factor

Severity of attack resulting from these products depends mainly upon the temperature. But, there is little attack if the ash is solid.

Mechanism of corrosion appears to incorporate several distinct activities: accelerated or catastrophic oxidation, evidently catalyzed by the V_2O_5, is one of the predominant features; fluxing of the protective Cr oxide by action of the alkali compound and formation of low melting sulfide phases are secondary, but none the less damaging effects.

There have been many investigations to determine whether a practical answer to this problem exists in the selection of better materials. Results of such studies have been uniformly discouraging. It now seems, the alternatives to using a noncorrosive distillate oil is either maintaining oil temperatures below the ash fusion range or else employing additives, such as oxides or sulfates of calcium, magnesium, aluminum, etc. These additives elevate the sintering temperature of the ash deposits.

What About Exotic Metals?

Most of our discussion on high-temperature metals for process use has centered around ferrous and nickel base alloys. The great majority of chemical process applications involve such alloys. But mention should be made of some other metals now undergoing intensive development as base materials for equipment. This group includes tungsten, molybdenum, titanium, tantalum and columbium (also important as alloying agents in ferrous and nickel alloys).

All these metals have melting points above 3,000 F. However molybdenum's big problem is in welding. Even under inert-atmosphere conditions welds rarely have ductility at room temperature. Also Mo is subject to catastrophic oxidation above 1,200 F.

Tantalum is used widely in chemical processing, but its safe temperature limits are low. At 347 F. tantalum reacts with chlorine, at higher temperatures it reacts with other gases. Tungsten, with a 6,170 F. melting point is very difficult to weld as it is brittle at room temperature.

Columbium and Cb-alloys represent a most promising area for future development. While expensive now, costs will come down and alloys will soon be available capable of withstanding temperatures of 1,800-2,000 F.

Also several companies are actively developing high-strength titanium alloys, which should prove useful in high-temperature process work.

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Substantial help and guidance was given the author in preparing this article by R. M. Wilson, supervisor, and G. P. Gladis, corrosion engineer, Technical Services Section, International Nickel Co., Inc., N. Y. Also thanks to G. A. Nelson, Shell Development Co., Emeryville, Calif. for permission to publish Fig. 6.

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Directory of Manufacturers

To help solve your material problems: an up-to-date compilation of basic (rods, tubes, pipe, sheet, resin powder) manufacturers of construction materials. These are major suppliers to the chemical process industries. Note that coatings and joining materials are not included in this directory.

1—Material Classification and Company Index

This first section of the directory includes a material classification and an index to manufacturers. Two code types are used: a material and company code number. See the alphabetical company listing, p. 152, to find who makes what.

MATERIAL CLASSIFICATION	MAT'L. CODE	MANUFACTURERS' CODE NUMBERS
1. Ferrous metals and alloys		
1. Irons		
1. Gray cast iron (2–5 C)	1.1.1	13, 33, 70, 72, 83, 114, 148, 182, 203, 230
2. Nickel cast iron	1.1.2	13, 33, 114, 148, 182, 203, 230, 240
3. High silicon cast iron (14.5 Si)	1.1.3	33, 78, 182, 203, 230
4. Ductile cast iron	1.1.4	33, 78, 148, 156, 203, 230
5. Electrolytic iron (0.006 C)	1.1.5	230
6. Wrought iron (0.05–0.15 C)	1.1.6	29, 42, 230
7. Other irons	1.1.7	83, 114, 230
2. Carbon steels (0.02–1.50 C)		
1. Wrought	1.2.1	29, 34, 70, 135, 152, 159, 166, 170, 187, 195, 206, 212, 214, 230, 232, 233
2. Cast	1.2.2	13, 34, 70, 72, 114, 150, 158, 203, 230
3. Carbon steels combined (clad, bonded) with:		
1. Copper	1.3.1	38, 159, 230
2. Glass	1.3.2	153, 179, 184, 208, 230
3. Lead	1.3.3	1, 172, 230
4. Nickel	1.3.4	1, 30, 56, 152, 159, 230
5. Nickel-chromium alloy	1.3.5	1, 56, 137, 152, 159, 230
6. Nickel-copper alloy	1.3.6	1, 38, 152, 159, 230
7. Plastic	1.3.7	15, 230, (See category 24)
8. Rubber	1.3.8	15, 230, (See category 25)
9. Stainless steel	1.3.9	1, 2, 38, 49, 56, 61, 64, 137, 152, 159, 195, 202, 206, 230
10. Other combined	1.3.10	38, 43, 56, 159, 173, 230
4. Alloy steels (wrought or cast)		
1. Moly	1.4.1	13, 27, 29, 34, 64, 70, 71, 114, 122, 135, 136, 137, 150, 158, 159, 166, 178, 195, 203, 206, 221, 230, 232, 233
2. Nickel	1.4.2	13, 27, 29, 34, 64, 70, 71, 114, 122, 136, 137, 150, 158, 159, 178, 195, 203, 206, 230, 232, 233, 240
3. Chrome	1.4.3	13, 27, 34, 64, 69, 70, 71, 114, 122, 135, 136, 137, 150, 158, 178, 195, 203, 206, 214, 230, 232, 233, 240
4 Chrome-moly	1.4.4	13, 27, 29, 34, 64, 70, 71, 72, 83, 114, 122, 135, 136, 137, 150, 158, 159, 178, 195, 203, 206, 221, 230, 232, 233
5. Chrome-nickel	1.4.5	13, 27, 34, 43, 64, 70, 71, 114, 122, 135, 136, 137, 150, 158, 178, 195, 203, 206, 230, 232, 233
6. Other alloy steels	1.4.6	13, 27, 34, 64, 70, 71, 72, 83, 114, 122, 135, 136, 150, 158, 159, 166 178, 195, 203, 206, 221, 230, 232, 233, 240, 243
5. Wrought stainless steels (AISI types)		
1. 301 (16–18 Cr; 6–8 Ni; 0.08–0.15 C)	1.5.1	2, 21, 35, 70, 80, 122, 136, 137, 164, 166, 195, 206, 214, 230, 232, 237 239
2. 302 (17–19 Cr; 8–10 Ni; 0.08–0.15 C)	1.5.2	2, 21, 29, 35, 49, 50, 70, 80, 122, 136, 137, 164, 166, 195, 206, 223, 224, 230, 232, 237, 239
3. 302B (17–19 Cr; 8–10 Ni; 0.08–0.15 C; 2–3 Si)	1.5.3	2, 21, 29, 70, 122, 136, 166, 195, 224, 230, 232, 164
4. 303 (17–19 Cr; 8–10 Ni; 0.15 max. C; 0.07 min. P or S or Se; 0.6 max. Zr or Mo; 2 max. Mn)	1.5.4	2, 21, 29, 35, 50, 70, 80, 122, 136, 137, 166, 195, 214, 223, 230, 232
5. 304 (18–20 Cr; 8–11 Ni; 0.08 max. C; 2 max. Mn)	1.5.5	2, 21, 29, 35, 49, 50, 51, 70, 71, 80, 122, 136, 137, 152, 164, 166, 195 206, 212, 214, 223, 224, 230, 232, 233, 237, 239
6. 304L (18–20 Cr; 8–11 Ni; 0.03 max. C)	1.5.6	2, 21, 29, 35, 49, 50, 51, 70, 80, 122, 136, 137, 152, 164, 166, 195, 206 212, 214, 223, 224, 230, 232, 237
7. 305 (17–19 Cr; 10–13 Ni; 0.012 max. C)	1.5.7	2, 21, 29, 35, 50, 70, 80, 122, 136, 137, 164, 166, 195, 206, 212, 214, 224, 230, 232, 237, 239

MATERIAL CLASSIFICATION	MAT'L. CODE	MANUFACTURERS' CODE NUMBERS
8. 308 (19–21 Cr; 10–12 Ni; 0.08 max. C)	1.5.8	2, 21, 29, 35, 51, 70, 80, 122, 136, 137, 166, 195, 212, 224, 230, 232, 164
9. 309 (22–24 Cr; 12–15 Ni; 0.2 max. C)	1.5.9	2, 21, 29, 35, 49, 70, 122, 136, 137, 166, 195, 212, 214, 224, 230, 232, 237, 164
10. 309S (22–24 Cr; 12–15 Ni; 0.08 max. C)	1.5.10	2, 21, 29, 35, 49, 51, 70, 80, 122, 136, 137, 166, 195, 206, 212, 224, 230, 232, 237, 164
11. 310 (24–26 Cr; 19–22 Ni; 0.25 max. C)	1.5.11	2, 21, 29, 49, 51, 70, 122, 136, 137, 166, 195, 206, 212, 214, 224, 230, 232, 233, 237, 239, 164
12. 310S (24–26 Cr; 19–22 Ni; 0.08 max. C)	1.5.12	2, 21, 29, 70, 80, 122, 136, 137, 166, 195, 212, 224, 230, 232, 164
13. 314 (23–26 Cr; 19–22 Ni; 0.25 max. C; 1.5–3 Si)	1.5.13	2, 21, 51, 70, 80, 122, 136, 166, 195, 212, 214, 230, 232, 164
14. 316 (16–18 Cr; 10–14 Ni; 0.1 max. C; 1.75–2.75 Mo)	1.5.14	2, 21, 29, 35, 49, 50, 51, 70, 71, 80, 122, 133, 136, 137, 152, 164, 166, 195, 206, 212, 214, 223, 224, 230, 232, 233, 237, 239
15. 316L (16–18 Cr; 10–14 Ni; 2–3 Mo; 0.03 max. C)	1.5.15	2, 21, 29, 35, 49, 50, 51, 70, 80, 122, 136, 137, 152, 164, 166, 195, 206, 212, 214, 223, 224, 230, 232, 237
16. 317 (17.5–20 Cr; 10–14 Ni; 0.1 max. C; 3–4 Mo)	1.5.16	2, 21, 29, 35, 49, 50, 51, 70, 80, 122, 136, 137, 152, 166, 195, 212, 214, 224, 230, 232, 237, 164
17. 321 (17–19 Cr; 8–11 Ni; 5XC min. Ti)	1.5.17	2, 21, 29, 35, 49, 50, 51, 70, 80, 122, 136, 137, 152, 164, 166, 195, 212, 214, 223, 224, 232, 237, 239
18. 347 (17–19 Cr; 9–12 Ni; 10XC min. Cb)	1.5.18	2, 21, 29, 35, 49, 50, 51, 70, 80, 122, 136, 137, 152, 164, 166, 195, 212, 214, 223, 224, 232, 233, 237, 239
19. 403 (11.5–13 Cr; 0.15 max. C)	1.5.19	2, 21, 29, 35, 50, 70, 122, 136, 166, 195, 214, 232, 164
20. 405 (11.5–13.5 Cr; 0.08 max. C; 0.1–0.3 Al)	1.5.20	2, 21, 29, 49, 70, 122, 136, 166, 195, 214, 232, 233, 240, 164
21. 410 (11.5–13.5 Cr; 0.15 max. C)	1.5.21	2, 21, 29, 35, 49, 50, 51, 70, 80, 122, 136, 137, 164, 166, 195, 214, 232, 237, 239
22. 414 (11.5–13.5 Cr; 1.25–2.5 Ni; 0.15 max. C)	1.5.22	2, 21, 29, 50, 70, 122, 136, 166, 195, 232, 237
23. 416 (12–14 Cr; 0.15 max. C; 0.07 min. S or P or Se; 0.6 max. Zr or Mo)	1.5.23	2, 21, 29, 50, 70, 122, 133, 137, 166, 195, 214, 232
24. 420 (12–14 Cr; 0.15 min. C)	1.5.24	2, 21, 29, 50, 70, 122, 136, 137, 166, 195, 214, 232
25. 430 (14–18 Cr; 0.12 max. C)	1.5.25	2, 21, 29, 35, 49, 50, 51, 70, 80, 122, 136, 137, 166, 195, 214, 224, 232, 233, 237, 239, 240, 164
26. 430F (14–18 Cr; 0.12 max. C; 0.07 min. S or P or Se; 0.6 max. Zr or Mo)	1.5.26	2, 21, 29, 35, 50, 70, 122, 136, 166, 195, 214, 232, 240, 164
27. 431 (15–17 Cr; 1.25–2.5 Ni; 0.2 max. C)	1.5.27	2, 21, 29, 70, 122, 136, 166, 195, 214, 232, 240
28. 440A (16–18 Cr; 0.6–0.75 C; 0.75 max. Mo)	1.5.28	2, 21, 29, 50, 70, 122, 136, 137, 166, 195, 214, 232, 240
29. 440B (16–18 Cr; 0.75–0.95 C; 0.75 max. Mo)	1.5.29	2, 21, 29, 50, 70, 122, 136, 137, 166, 195, 232, 240
30. 440C (16–18 Cr; 0.95–1.2 C; 0.75 max. Mo)	1.5.30	2, 21, 29, 50, 70, 122, 136, 137, 166, 195, 232, 240
31. 446 (23–27 Cr; 0.35 max. C; 0.25 max. N)	1.5.31	2, 29, 35, 70, 80, 122, 136, 137, 166, 164, 214, 232, 240
32. 501 (4–6 Cr; 0.1 min. C)	1.5.32	2, 34, 70, 122, 136, 166, 164, 232, 240
33. 502 (4–6 Cr; 0.1 max. C)	1.5.33	2, 34, 70, 122, 136, 166, 164, 232, 240
34. Other stainless steels	1.5.34	2, 49, 50, 51, 70, 80, 122, 133, 136, 166, 164, 224, 240
6. Cast high alloys (ACI types):		
1. CA-15 (11–14 Cr; 1 max. Ni; 0.15 max. C)	1.6.1	2, 13, 36, 43, 64, 70, 76, 84, 87, 102, 150, 158, 178, 203, 211, 230, 240
2. CA-40 (11–14 Cr; 1 max. Ni; 0.2–0.4 C)	1.6.2	2, 13, 36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 203, 211, 230, 240
3. CB-30 (18–22 Cr; 2 max. Ni; 0.3 max. C)	1.6.3	2, 13, 36, 43, 64, 70, 76, 84, 87, 102, 150, 158, 178, 203, 211, 230, 240
4. CC-50 (26–30 Cr; 4 max. Ni; 0.5 max. C)	1.6.4	2, 13, 36, 43, 64, 70, 76, 84, 87, 102, 150, 158, 178, 203, 211, 230, 240
5. CE-30 (26–30 Cr; 8–11 Ni; 0.3 max. C)	1.6.5	2, 13, 36, 43, 64, 70, 76, 84, 87, 102, 150, 158, 178, 203, 211, 230, 240
6. CF-8 (18–20 Cr; 8–10 Ni; 0.08 max. C)	1.6.6	2, 8, 13, 36, 43, 64, 70, 76, 78, 84, 87, 102, 137, 150, 158, 178, 182, 203, 211, 230, 240
7. CF-20 (18–20 Cr; 8–10 Ni; 0.2 max. C)	1.6.7	2, 13, 36, 43, 64, 70, 76, 84, 87, 102, 137, 150, 158, 178, 182, 203, 211, 230, 240
8. CF-16F (18–20 Cr; 8–10 Ni; 0.08 max. C; 0.2–0.35 Se)	1.6.8	2, 13, 36, 43, 64, 70, 76, 84, 87, 102, 150, 158, 178, 211, 203, 230, 240
9. CF-8C (18–20 Cr; 8–10 Ni; 0.08 max. C; 8XC min.-1 max. Cb)	1.6.9	2, 8, 13, 36, 43, 64, 70, 76, 84, 87, 102, 137, 150, 158, 178, 203, 211, 230, 240
10. CF-8M (18–20 Cr; 8–10 Ni; 0.08 max. C; 2–3 Mo)	1.6.10	2, 8, 13, 36, 43, 64, 70, 76, 78, 87, 102, 137, 150, 158, 178, 182, 203, 211, 230, 240
11. CF-12M (18–20 Cr; 8–10 Ni; 0.12 max. C; 2–3 Mo)	1.6.11	2, 36, 43, 64, 70, 76, 87, 102, 137, 150, 158, 178, 203, 211, 230, 240
12. CH-20 (22–26 Cr; 12–15 Ni; 0.2 max. C)	1.6.12	2, 13, 36, 43, 64, 70, 76, 84, 87, 102, 137, 150, 158, 178, 182, 203, 211, 230, 240
13. CK-20 (23–75 Cr; 19–22 Ni; 0.25 max. C)	1.6.13	2, 13, 36, 43, 64, 70, 76, 84, 87, 102, 137, 150, 158, 178, 203, 211, 230, 240
14. CN-7M (18–22 Cr; 21–31 Ni; 0.07 max. C)	1.6.14	8, 13, 36, 43, 64, 70, 76, 78, 87, 102, 150, 158, 178, 203, 211, 230, 240, 241
15. HA (8–10 Cr; 0 Ni; 0.2 max. C; 0.9–1.2 Mo)	1.6.15	36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 203, 230, 240
16. HC (26–30 Cr; 4 max. Ni)	1.6.16	2, 36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 203, 230, 240
17. HD (26–30 Cr; 3–6 Ni)	1.6.17	2, 36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 203, 230, 240
18. HE (26–30 Cr; 8–11 Ni)	1.6.18	2, 10, 36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 203, 230, 240
19. HF (18–23 Cr; 8–12 Ni)	1.6.19	2, 13, 36, 43 64, 70, 76, 87, 102, 150, 158, 178, 182, 203, 230, 240
20. HH (24–27 Cr; 11–14 Ni)	1.6.20	2, 10, 13, 36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 182, 203, 230, 240
21. HI (26–30 Cr; 13–17 Ni)	1.6.21	2, 36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 203, 230, 240
22. HK (24–27 Cr; 18–22 Ni)	1.6.22	2, 10, 13, 36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 182, 203, 230, 240
23. HL (28–32 Cr; 18–22 Ni)	1.6.23	2, 10, 36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 203, 230, 240
24. HN (19–23 Cr; 23–27 Ni)	1.6.24	36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 203, 230, 240
25. HT (13–17 Cr; 33–37 Ni)	1.6.25	2, 13, 36, 43, 64, 70, 76, 87, 102, 137, 150, 158, 178, 203, 230, 240
26. HU (17–21 Cr; 37–41 Ni)	1.6.26	2, 36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 203, 230, 240
27. HW (10–14 Cr; 58–62 Ni)	1.6.27	13, 36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 203, 230, 240
28. HX (15–19 Cr; 64–68 Ni)	1.6.28	36, 43, 64, 70, 76, 87, 102, 150, 158, 178, 203, 230, 240
7. Other ferrous alloys not covered above	1.7	2, 21, 70, 84, 87, 150
2. Aluminum and aluminum alloys		
1. 1100 (99.0 min. Al)	2.1	6, 38, 44, 122, 138, 152, 170, 197, 198, 202, 205
2. 1160 (99.6 Al)	2.2	6, 38, 122, 152, 198, 202
3. 2024 (Al; 4.5 Cu; 1.5 Mg; 0.6 Mn)	2.3	6, 44, 122, 138, 197, 198, 202
4. 3003 (Al; 1.2 Mn)	2.4	6, 38, 122, 138, 170, 197, 198, 202, 205
5. 3003 Alclad (3003 clad with Al-1 Zn)	2.5	6, 122, 198, 202
6. 3004 (Al; 1.2 Mn; 1 Mg)	2.6	6, 122, 138, 197, 198, 202
7. 3004 Alclad (3004 clad with Al-1 Zn)	2.7	6, 122, 138, 198, 202
8. 5005 (Al; 1.2 Mg)	2.8	6, 122, 138, 170, 197, 198, 202, 205
9. 5050 (Al; 1.3 Mg)	2.9	6, 122, 138, 170, 197, 198, 202
10. 5052 (Al; 2.5 Mg; 0.25 Cr)	2.10	6, 122, 138, 170, 197, 198, 202
11. 5154 (Al; 3.5 Mg; 0.25 Cr)	2.11	6, 122, 138, 198, 202
12. 6061 (Al; 0.25 Cu; 0.6 Si; 0.25 Cr; 1.0 Mg)	2.12	6, 38, 44, 122, 138, 170, 197, 198, 202

Materials of Construction

MATERIAL CLASSIFICATION	MAT'L. CODE	MANUFACTURERS' CODE NUMBERS
Aluminum and aluminum alloys (cont.)		
13. 6063 (Al; 0.6 Si; 0.7 Mg)	2.13	6, 38, 44, 122, 138, 197, 198, 202
14. 43 (Al; 5 Si)	2.14	6, 18, 122, 138, 170, 198, 202, 240
15. 214 (Al; 3.8 Mg)	2.15	6, 122, 138, 198, 202, 240
16. B214 (Al; 3.8 Mg; 1.8 Si)	2.16	6, 122, 138, 198
17. 356 (Al; 7 Si; 0.3 Mg)	2.17	6, 18, 122, 138, 198, 240
18. Other aluminum alloys	2.18	18, 97, 122, 197, 198,
3. Beryllium and Be-alloys	3	32, 39, 165, 214
4. Cobalt alloys		
1. Co-Cr-W alloys	4.1	211, 227
2. Co-Cr-W-Ni alloys	4.2	150, 212, 227
5. Copper and copper alloys		
1. Coppers		
1. Electrolytic tough pitch (99.9 plus Cu)	5.1.1	11, 12, 38, 53, 152, 185, 197
2. Deoxidized (99.9 plus Cu)	5.1.2	11, 12, 38, 53, 152, 170, 185, 197, 205
3. Arsenical (99.4 plus Cu; 0.3 As)	5.1.3	12, 38, 53, 185, 197, 205
4. Other coppers	5.1.4	11, 170, 185, 197
2. Cu-Zn alloys		
1. Admiralty (70 Cu; 29 Zn; 1 Sn)	5.2.1	38, 44, 185, 197, 205
2. Admiralty, arsenical (70 Cu; 29 Zn; 1 Sn; 0.04 As)	5.2.2	12, 38, 44, 53, 185, 197, 205
3. Brass, aluminum (76 Cu; 22 Zn; 2 Al)	5.2.3	38, 44, 185, 197, 205, 240
4. Brass, cartridge (70 Cu; 30 Zn)	5.2.4	38, 44, 185, 197, 240
5. Brass, low zinc (80 Cu; 20 Zn)	5.2.5	17, 38, 44, 185, 197, 240
6. Brass, naval (60 Cu; 39.25 Zn; 0.75 Sn)	5.2.6	12, 38, 170, 185, 197, 205, 240
7. Brass, red (85 Cu; 15 Zn)	5.2.7	11, 12, 17, 38, 44, 53, 170, 185, 197, 205, 240
8. Brass, silicon red (82 Cu; 17 Zn; 1 Si)	5.2.8	17, 240
9. Brass, yellow (63–65 Cu; 35–37 Zn)	5.2.9	18, 38, 44, 170, 185, 197, 240
10. Bronze, commercial (90 Cu; 10 Zn)	5.2.10	17, 38, 44, 170, 185, 197, 240
11. Bronze, comm. hi-str. (90.25 Cu; 6.9 Zn; 1.75 Pb; 1 Ni)	5.2.11	17, 240
12. Bronze, manganese (59 Cu; 39 Zn; 0.7 Sn; 0.5 Mn; 0.8 Fe)	5.2.12	11, 16, 18, 20, 38, 170, 197, 205, 240
13. Munts metal (60 Cu; 40 Zn)	5.2.13	12, 38, 185, 197, 205
14. Other Cu-Zn alloys	5.2.14	12, 16, 18, 170, 185, 197
3. Cu-Ni alloys		
1. Cupro-nickels (60–90 Cu; 10–40 Ni)	5.3.1	12, 16, 38, 44, 53, 185, 197, 205, 240
2. Nickel-silvers (55–75 Cu; 10–20 Ni; 5–27 Zn)	5.3.2	38, 197, 240
3. Other Cu-Ni alloys	5.3.3	44, 170
4. Cu-Sn alloys		
1. Bronze, phosphor (88–98.75 Cu; 1.25–10.5 Sn; P)	5.4.1	11, 12, 16, 38, 197, 240
2. Other Cu-Sn alloys	5.4.2	16, 170, 185
5. Cu-Al alloys		
1. Bronze, aluminum (82–95 Cu; 5–10 Al)	5.5.1	11, 12, 16, 18, 20, 38, 185, 197, 205, 240
2. Bronze, Al. silicon (91–95.5 Cu; 3.5–7 Al; 1–2 Si)	5.5.2	38, 170, 197, 205, 230
3. Other Cu-Al alloys	5.5.3	16, 18, 20, 170
6. Cu-Si alloys		
1. Bronze, silicon (97–98.1 Cu; 1.9–3 Si)	5.6.1	16, 18, 38, 53, 152, 197, 205, 240
2. Other Cu-Si alloys	5.6.2	18
7. Other copper alloys	5.7	12, 38, 170
6. Indium and indium alloys	6	17
7. Lead and lead alloys		
1. Chemical lead (99.9 min. Pb)	7.1	17, 18, 41, 109, 144, 172, 176, 181
2. Acid lead (99.9 min. Pb)	7.2	17, 18, 144, 172, 176, 181
3. Copper lead (99.85 min. Pb)	7.3	17, 18, 41, 144, 172, 176, 181
4. Antimonial (hard) lead (Pb; 1–12 Sb)	7.4	16, 17, 18, 41, 109, 144, 172, 176, 181
5. Tellurium lead (Chem. lead plus 0.04 Te)	7.5	17, 18, 41, 144, 172, 176, 181
6. Other lead alloys	7.6	11, 17, 18, 41, 109, 144, 172, 176, 181
8. Molybdenum and Mo-alloys	8	38, 44, 59, 91, 181, 236
9. Magnesium and Mg-alloys	9	74
10. Nickel and nickel alloys		
1. Nickel	10.1	8, 35, 102, 131, 150, 152, 166, 211, 214, 240
2. Ni Cu alloys	10.2	8, 16, 35, 131, 150, 152, 166, 211, 214, 240
3. Ni-Cr alloys	10.3	8, 35, 78, 87, 103, 131, 150, 152, 166, 211, 214, 224, 240
4. Ni-Mn alloys	10.4	35, 150, 166, 214
5. Ni-Mo and Ni-Mo-Fe (Cr) alloys	10.5	8, 78, 87, 150, 166, 211, 214, 224, 227
6. Other nickel alloys	10.6	8, 150, 166, 211, 224, 227
11. Noble metals and alloys		
1. Gold (99.9 plus Au)	11.1	35, 109, 119, 165
2. Paladium (99.9 plus Pd)	11.2	35, 109, 119, 165
3. Platinum (99.9 plus Pt)	11.3	35, 109, 119, 165
4. Rhodium (99.9 plus Rh)	11.4	35, 109, 165
5. Silver (99.9 plus Ag)	11.5	35, 41, 109, 119, 165
6. Other noble metals and alloys	11.6	35, 119, 165
12. Tantalum (99.9 plus Ta)	12	35, 91, 139, 143, 165, 236

MATERIAL CLASSIFICATION	MAT'L. CODE	MANUFACTURERS' CODE NUMBERS
13. Columbium (niobium) and Cb-alloys	13	35, 38, 91, 139, 226, 236
14. Titanium and titanium alloys.		
1. Titanium (99 plus Ti)	14.1	29, 38, 44, 70, 79, 122, 161, 165, 181, 214, 222, 224
2. Ti-Cr alloys	14.2	38, 70, 122, 181, 222
3. Ti-Mn alloys	14.3	38, 70, 122, 181
4. Other titanium alloys	14.4	38, 70, 122, 161, 181, 222
15. Tin and Sn-alloys	15	11, 236
16. Tungsten and W-alloys	16	91, 103, 166, 236
17. Vanadium and V-alloys	17	165, 166, 181, 226, 235
18. Zinc and Zn-alloys	18	17, 174
19. Zirconium (99 plus Zr-Hf) and alloys	19	2, 38, 44, 47, 51, 62, 95, 122, 161, 165, 181, 214, 224, 236
20. Other metals and alloys	20	35, 51, 131, 181, 236
21. Asbestos materials	21	17, 22, 23, 106, 134, 142, 192, 200, 204, 231
22. Carbon and graphite materials		
1. Plain carbon	22.1	116, 117, 141, 210, 228
2. Plain graphite	22.2	116, 117, 141, 210, 228
3. Impervious carbon (resin impregnated)	22.3	116, 141, 210, 228
4. Impervious graphite (resin impregnated)	22.4	90, 116, 124, 141, 210, 228
23. Ceramic materials		
1. Glass	23.1	23, 68, 153, 154, 179, 180, 188
2. Fused silica	23.2	19, 68, 92, 154, 188, 218, 220
3. Chemical porcelain	23.3	65, 92, 145, 151, 163, 183, 234
4. Stoneware	23.4	145, 234
5. Refractories, brick, structural clay	23.5	28, 46, 67, 86, 120. 129, 132, 134, 138, 145, 163, 175, 177, 191, 199, 216, 238, 244
6. Other ceramic materials	23.6	65, 68, 103, 143, 145, 157, 183, 234
24. Plastic materials		
1. Phenolics	24.1	3, 45, 58, 77, 103, 104, 123, 126, 127, 167, 169, 194, 200, 215, 225
2. Ureas	24.2	14, 45, 104, 115
3. Melamines	24.3	14, 104, 215
4. Polyesters	24.4	3, 14, 25, 31, 103, 104, 123, 124, 127, 128, 130, 168, 169, 194, 201, 225, 231
5. Epoxies	24.5	7, 31, 57, 74, 78, 93, 104, 130, 167, 168, 194, 207, 215, 225, 231
6. Vinyls		
1. Polyvinyl chloride materials — Type I	24.6.1	5, 9, 15, 24, 37, 48, 60, 73, 82, 89, 93, 101, 104, 107, 108, 111, 112, 113, 121, 130, 135, 140, 147, 160, 162, 169, 170, 213, 225, 231, 233, 234
2. Polyvinyl chloride materials — Type II	24.6.2	5, 9, 15, 24, 37, 45, 48, 60, 73, 82, 89, 93, 104, 107, 108, 112, 121, 130, 140, 147, 160, 162, 169, 170, 225, 233
3. Polyvinylidene chloride	24.6.3	15, 74, 104, 115, 118
4. Other vinyls	24.6.4	7, 24, 93, 104, 112, 140, 145, 196, 15
7. Acrylics	24.7	79, 104, 160
8. Polystyrenes	24.8	14, 45, 74, 104, 146, 160, 225, 242, 48
9. Nylons	24.9	3, 79, 99, 100, 104, 160, 189, 193, 209, 242, 48
10. Polyethylenes	24.10	4, 9, 48, 37, 40, 52, 74, 79, 81, 107, 115, 125, 130, 135, 146, 160, 169, 170, 171, 186, 193, 209, 225, 233, 242
11. Fluorocarbons		
1. Polytetrafluoroethylenes	24.11.1	54, 55, 69, 79, 96. 99, 100, 123, 189, 192, 193, 196, 234
2. Polytrifluorochloroethylenes	24.11.2	96, 99, 100, 104, 167, 196
3. Other fluorocarbons	24.11.3	99, 104
12. Silicones	24.12	75, 104, 105
13. Cellulosics		
1. Cellulose nitrate	24.13.1	
2. Cellulose acetate	24.13.2	48, 52, 81, 104
3. Cellulose acetate-butyrate	24.13.3	37, 48, 81, 104
14. Polyurethanes	24.14	104, 108, 231
15. Other plastic materials	24.15	45, 52, 98, 103, 104, 123, 125, 189, 231, 48
25. Rubber-like materials		
1. Natural rubber		
1. Hard	25.1.1	26, 101, 106, 112, 113, 160, 192, 193, 231, 110
2. Soft	25.1.2	26, 94, 99, 101, 106, 112, 113, 149, 155, 190, 192, 231, 110
2. Butadiene-styrene rubber	25.2	26, 66, 94, 99, 106, 107, 110, 111, 112, 113, 149, 190, 192, 193, 217, 231, 15
3. Nitrile rubber	25.3	26, 94, 99, 106, 110, 111, 112, 113, 126, 149, 160, 190, 193, 200, 231, 15
4. Chloroprene rubber	25.4	26, 79, 99, 101, 106, 112, 113, 149, 190, 193, 15
5. Butyl rubber	25.5	26, 85, 88, 99, 106, 110, 111, 112, 113, 149, 190, 192, 193, 110
6. Polysulfide rubber	25.6	106, 149, 190, 193, 219
7. Silicone rubber	25.7	63, 75, 99, 104, 105, 106, 149, 190, 192, 193, 200, 201, 229
8. Chlorosulfonated polyethylene	25.8	26, 79, 101, 106, 112, 113, 149, 193
9. Other rubber-like materials	25.9	26, 45, 79, 99, 106, 111, 113, 126, 145, 149, 167
26. Other nonmetallic materials	26	81, 145, 200

2—Listing of Basic Manufacturers

Who makes basic materials of construction. To find material codes and codes of all companies making a particular product, see p. 148.

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
1	Alco Products, Inc. Schenectady, N. Y.	1.3.3, 1.3.4–1.3.6, 1.3.9	Hi-Qua-Led	Forgings	Flanges, tubesheets, vessels, piping	
2	Allegheny Ludlum Steel Corp. Pittsburgh, Pa.	1.3.9, 1.5.1–1.5.34		Bars, blocks, tubes, rods, wire, sheets	Heat-exchanger tubing, towers, tanks, pipe	
		1.6.1–1.6.13, 1.6.16–1.6.23, 1.6.25–1.6.26		Castings	Fractionating tower sections, agitators, valve parts, pump parts, autoclaves, digesters, evaporators	
		1.7		Bars, tubes, sheets		AM 350, AM 355
		19		Bars, tubes, sheets	Heat exchangers, reactors, piping	
3	Allied Chemical Corp. Plastics and Coal Chemicals Div. New York, N. Y.	24.1, 24.4	Plaskon	Liquid resin	Pipes, pipe fittings, ducts	Used with glass reinforcement
		24.9	Plaskon	Molding powder	Tubing, pipe, pipe fittings	
4	Allied Chemical Corp. Semet-Solvay Petrochemical Div. New York, N. Y.	24.10	A-C Polyethylene	Uniform cube, pellets	Piping, valves, liners	
5	Alpha Plastics, Inc. Livingston, N. J.	24.6.1 24.6.2	Alpha 101 Alpha 102	Rods, bar, tubular, wire	Pipe, fittings, valves, structural shapes	Special extruded shapes available
6	Aluminum Company of America Pittsburgh, Pa.	2.1–2.13		Sheet, plate, tubular	Tanks, piping, heat exchanger tubes, chemical equipment	
		2.14–2.17		Castings	Pump bodies, untrace flanges, misc. cast equipment	
7	Amercoat Corp. South Gate, Calif.	24.5	Bondstrand	Pipe and fittings	Piping, ducting, flues	Fiber-glass reinforced, 2 thru 8-in. dia.
		24.6.4	Amer-Plate	Sheet	Tank and sewer lining	Polyvinyl chloride, non-rigid
8	Alloy Steel Products Co. Linden, N. J.	1.6.6 1.6.9 1.6.10 1.6.14 10.1 10.2 10.5 10.6 10.3 1.6.14	Alloyco 18-8S Alloyco 18-8S Cb Alloyco 18-8S Mo Alloyco 20 Alloyco Nickel Alloyco Monel Alloyco N-2 Alloyco N-4 Alloyco Inconel Alloyco Worthite	Castings	Valves, steam-jacketed fittings	
9	American Agile Corp. Bedford, Ohio	24.6.1, 24.6.2, 24.10		Molded parts		
10	American Brake Shoe Co. Electro-Alloys Div. Elyria, Ohio	1.6.22, 1.6.23	Thermalloy	Castings	Reformer furnace tubes	Tubing 3–30-in. O. D.
		1.6.20, 1.6.18, 1.6.22	Thermalloy	Castings	Hangers, tube supports, tube sheets	
11	American Brake Shoe Co. National Bearing Div. Pittsburgh, Pa.	5.1.1, 5.1.2		Castings	High-thermal and electrical conductivity applications	
		5.1.4		Castings	High-thermal and electrical conductivity applications	Chromium-copper alloy
		5.2.7		Castings		
		5.2.12		Castings	High-strength parts	
		5.4.1		Castings	Bearings	
		5.5.1		Castings	Nonsparking, nonmagnetic and corrosion resisting applications	
		7.6		Casting, pigs	Bearings	Lead-base babbits
		15		Casting, pigs	Bearings	Tin-base babbits

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
12	American Brass Co. Waterbury, Conn.	5.1.1, 5.1.2, 5.2.6, 5.2.7, 5.3.1, 5.2.2, 5.2.14, 5.2.13, 5.1.3	Anaconda	Wrought forms	Heat exchanger tubing, tube sheets, baffles	
		5.7, 5.5.1	Ambraloy	Tubes	Heat exchanger tubing, tube sheets, baffles	
		5.4.1	Ambronze	Tubes	Heat exchanger tubes	
		5.6	Everdur	Bars, tubes, sheets, rods	Tube sheets, tank metal	
13	American Chain and Cable Co. Acco Casting Div. Reading, Pa.	1.1.1, 1.1.2, 1.2.2, 1.4.1–1.4.6, 1.6.1–1.6.10, 1.6.12–1.6.14, 1.6.19, 1.6.20, 1.6.22, 1.6.25, 1.6.27		Castings	Pumps, valves, liquid handling equipment	
14	American Cyanamid Co. New York, N. Y.	24.3	Cymel 1077	Pump impellers, pump casings, agitator blades, tanks and tank linings		
		24.2	Beetle			
		24.8	Cymac 201			
		24.4	Laminac			
15	American Hard Rubber Co. New York, N. Y.	24.6.1–24.6.4, 25.2–25.4, 1.3.7, 1.3.8		Tubing, sheets, molding	Piping systems, linings	
16	American Manganese Bronze Co. Philadelphia, Pa.	5.2.12	Manganese bronze	Castings and forgings	Valve bodies and stems	
		5.2.14	Turbine Metal	Castings	Pump impellers and casings, valve bodies	Nickel-Manganese bronze
		5.2.14	Hy-ten-al	Castings, rod, forgings	Valve bodies and parts, pump impellers	High-tensile Al-Mg bronze
		5.3.1	Cupro-nickel	Castings	Pump and valve parts	
		5.4.1	Phos. bronze	Castings	Pump impellers	Usually contains 1–2% Ni
		5.4.?	Still Metal	Castings	Evaporator bodies and covers	86% Cu; 14% Sn
		5.5.1	Resistac	Castings	Pump and valve parts	Contains 1–4% Fe
		5.5.3	Resistac	Castings and forgings	Valve bodies, stems, pump impellers and casings	Ni-Al bronze
		5.6.1	Silicon bronze	Castings	Valve and pump parts	
		7.4	Hard lead	Castings	Bodies and fittings	
		10.2	Monel	Castings	Pump impellers	
17	American Smelting and Refining Co. New York, N. Y.	5.2.5, 5.2.7, 5.2.8, 5.2.10, 5.2.11	Asarcon continuous cast bronze	Bars, tubes and special continuous shapes	Tubing	⅛ to 9-in. dia., cut to 105-in. lengths
		6	Asarco indium	Billets, foil, strip		
		7.1–7.6	Asarco lead	Sheet, pipe, coil. fittings	Tank linings, gaskets	
		18	Asarco zinc	Ingots		
		21	Lake Asbestos	Chrysotile, all grades		
18	American Smelting and Refining Co. Federated Metals Div. New York, N. Y.	2.14, 2.17, 2.18, 5.2.9, 5.2.12, 5.2.14, 5.5.1, 5.5.3, 5.6.1, 5.6.2		Ingots	Valves, fittings	
		7.1–7.6		Sheets, pipe, fittings, special shapes	Tank linings, heating and cooling coils	
19	Amersil Co. Hillside, N. J.		Amersil	Tubular, rods, sheets, plates	Pipe and fittings, pots, crucibles, trays, muffles, tubing	Opaque and transparent
		23.2	Rotosil	Tubular	Tubes, pipe (conical, flanged, welded) and fittings, crucibles, pots	
			Optosil	Plates, ingots	Sight ports	
20	Ampco Metal Inc. Milwaukee, Wisc.	5.5.1, 5.5.3		Sheets, plates, rods, bars, wire	Pump components, valve components, vessels, heat exchanger tubing	
		5.2.12		Castings, forgings		
21	Armco Steel Corp. Middletown, Ohio	1.5.1–1.5.30, 1.7		Bars, wire, sheets, plate	Process equipment	
22	Armstrong Cork Co. Lancaster, Pa.	21	Accopac	Sheets	Gaskets	
23	Atlas Asbestos Co. North Wales, Pa.	23.1	Glaspun	Woven or braided tubing	Plastic reinforced tubing	
		21	Atlas	Braided tube or rope	Gaskets, pipe lagging	
24	Atlas Mineral Products Co. Mertztown, Pa.	24.6.1	Ampcoflex	Sheet and pipe	Self-supporting tank, tank lining, scrubber bodies, collectors	Corrosion-proof rigid plastic
		24.6.2	Pee Vee Cee	Sheet and pipe, pipe fittings		
		24.6.4	Atlastavon, Atlastaflex	Sheet	Tank lining	Corrosion-proof lining for steel vessels

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
25	Atlas Powder Co. Wilmington, Del.	24.4		Molding powder for reinforced plastics	Filter press plates	
26	Automotive Rubber Co., Inc. Detroit, Mich.	25.1.1, 25.1.2, 25.2, 25.3, 25.4, 25.5, 25.8, 25.9		Sheet	Tank and pipe linings	
27	Babcock and Wilcox Co. Boiler Div. New York, N. Y.	1.4.1–1.4.6		Special custom castings		
28	Babcock and Wilcox Co. Refractories Div. New York, N. Y.	23.5	Kaocrete	Castable[3]	Kiln and furnace construction	
			Kaocast	Castable[3]		
			Kaolite	Castable[3]		
			Firebrick	Brick		
			Insulating Firebrick	Brick	High-temperature insulation	Temperature limits of 1,600, 2,000, 2,300, 2,600, 2,800 and 3,000 F.
29	Babcock and Wilcox Co. Tubular Products Div. Beaver Falls, Pa.	1.1.6		Tubes	Piping	
		1.2.1, 1.4.1, 1.4.2, 1.4.4, 1.5.2–1.5.12, 1.5.14–1.5.31, 14.1		Tubes, fittings, flanges	Piping, heat exchanger tubes	
30	Bart Manufacturing Corp. Belleville, N. J.	1.3.4	Bart Lectro-Clad	Sheets, plates, pipe, tubing, fittings	Heat exchanger tubing, vessels	
31	Carl N. Beetle Plastics Corp. Fall River, Mass.	24.4, 24.5	Bonate	Sheets, tubes, pipes	Tanks, hoods, piping, ducting, vents	Piping sizes to 54-in. dia.
32	Beryllium Corp. Reading, Pa.	3	Berylco	Rod, bar, strip, wire castings, extrusions, billet	Nuclear reactor parts, missile components	Beryllium metal and beryllium-copper alloy
33	Bethlehem Foundry and Machine Co. Bethlehem, Pa.	1.1.1–1.1.4		Castings	Autoclaves, pots, retorts, sulfonators, agitators, impellers, pumps, flow tubes	
34	Bethlehem Steel Co. Bethlehem, Pa.	1.2.1		Bars, tubes, sheets	All types of equipment and components, fabricated to specification	
		1.2.2		Castings		
		1.4.1–1.4.6		Bars, tubes, sheets, castings		
		1.5.32		Bars		
		1.5.33		Bars		
35	J. Bishop and Co. Platinum Works Malvern, Pa.	11.1–11.6		Wire, sheet, foil, tube, liners, fabricated parts	Equipment linings, thermowells	
		10.1–10.4, 1.5.1, 1.5.2, 1.5.4–1.5.10, 1.5.14–1.5.19, 1.5.21, 1.5.25, 1.5.26, 1.5.31, 12, 13		Tubular products	Heat exchanger and process tubing	
		20		Tubular products		17-7 PH, A-286
36	Blaw-Knox Co. National Alloy Div.	1.6.1–1.6.28		Castings, static and centrifugal	Furnace parts, valve and pump components, high-temperature applications	
37	Borden Co. Resin Industries Sub. Santa Barbara, Calif.	24.6.1, 24.6.2, 24.10, 24.13.3	Resinite	Tubular	Pipe	
38	Bridgeport Brass Co. Bridgeport, Conn.	1.3.1, 1.3.6, 1.3.9, 1.3.10	Duplex	Tube, sheet	Heat exchanger tubes and tube sheets	Mechanically bonded metal
		2.1, 2.2, 2.4, 2.12, 2.13	Bridgeport	Sheet, rod, wire, tube extrusions	Reactors, dryers, crystallizers	
		5.1.1–5.1.3, 5.2.1–5.2.7, 5.2.9, 5.2.10, 5.2.12, 5.2.13, 5.3.1, 5.3.2, 5.4.1, 5.5.1, 5.5.2, 5.6.1, 5.7		Rod, sheet, wire, tube	Condensers, heat exchangers, tube sheets, electrical parts	
		5, 13, 14.1–14.4, 19			Special process equipment	Custom engineered

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
39	Brush Beryllium Co. Cleveland, Ohio	3	QMV	Bars, sheet, block, powder, tubes, extrusions and various machined shapes	Missile parts, nuclear reactor moderators and reflectors	QMV specifically refers to vacuum cast, powdered, hot press method of making Be block from which other forms are derived
40	Broadway Rubber Corp. Acme-Fisher Div. Louisville, Ky.	24.10	Laybond	Sheet	Tank linings	Chlorosulfonated polyethylene
41	Bunker Hill Co. San Francisco, Calif.	7.1, 7.3, 7.4, 7.5, 7.6		Bars, tubes, sheets, wire	Tank linings, vessels	
		11.5		Bars		
42	A. M. Byers Co. Pittsburgh, Pa.	1.1.6		Tubular, bars, plates	Pipe, tanks, vats	
43	Calorising Co. Wilkinsburg, Pa.	1.3.10	Calite	Plates, bars, tubes, sheets, castings, forgings	Heat exchanger tubes, refinery tubing, furnace hearth assembly	
		1.4.5, 1.6.1–1.6.28	Calite	Castings, centrifugal tubes	Heater tube supports, heat treating furnace hearths, conveyor rollers, agitators and mixers, forming rolls, heater tubes (cast)	
44	Calumet and Hecla, Inc. Wolverine Tube Div. Allen Park, Mich.	2.1, 2.3, 2.12, 2.13, 5.2.1, 5.2.2, 5.2.3, 5.2.4, 5.2.5, 5.2.7, 5.2.9, 5.2.10, 5.3.1, 5.3.3, 8, 14.1, 19		Tubing	Heat exchanger tubing	
45	Carboline Co. St. Louis, Mo.	24.1, 24.5, 24.6.2, 24.15, 24.8, 25.9		Liquid	Tank linings	
		25.9		Sheet	Tank linings	
46	Carborundum Co. Refractories Div. Perth Amboy, N. J.	23.5	Carbofrax	Brick, shapes, cement	Roasters, classifiers, muffles, HCl burners, recuperators	Silicon carbide
			Alfrax	Brick, shapes, cement	Atmosphere muffles, burner block	Bonded alumina
			Monofrax	Blocks	Glass tanks, slagwool furnaces	Fused cast alumina
			Mullfrax	Brick, shapes, cement	Pouring cups, burner blocks, carbon black furnaces	Mullite
			Refrax	Brick, shapes	Pumps, pump covers, impellers holding pots, thermocouples, spray nozzles	Silicon nitride, bonded silicon carbide
47	Carborundum Metals Co. Akron, N. Y.	19		Ingots, billets, bars, rod, sheet, strip, plate, seamless and welded tubing, wire, castings	Heat exchanger tubing, valve bodies, reaction vessels, liners, thermowells, pump impellers, pump casings	
48	Carlon Products Corp. Cleveland, Ohio	24.6.1, 24.6.2, 24.8, 24.9, 24.10, 24.13.2, 24.13.3, 24.15		Pipe, tubing	Piping systems	
49	G. O. Carlson, Inc. Thorndale, Penna.	1.3.9, 1.5.2, 1.5.5, 1.5.6, 1.5.9, 1.5.10, 1.5.11, 1.5.14–1.5.18, 1.5.20, 1.5.21, 1.5.25, 1.5.33, 1.5.34		Plates, plate products, heads, rings, circles flanges, forgings, bars, sheets (No. 1 finish)	Heat exchangers, reaction vessels, towers, dryers	317L, 348, 17-4PH, 17-7PH, PH15-7 MO
50	Carpenter Steel Co. Reading, Pa.	1.5.2, 1.5.5, 1.5.6		Bars, wire, strip, billets	Nitric acid vessels and other chemical process equipment	
		1.5.14–1.5.16, 1.5.25		Bars, wire, strip, billets	Chemical process equipment	
		1.5.26, 1.5.29		Bars, wire, billets	Chemical process equipment	
		1.5.17, 1.5.18		Bars, wire, strip, billets	High-temperature chemical process equipment	Type 348 also used
	(Cont.)					

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
50	Carpenter Steel Co. (cont.)	1.5.22, 1.5.28		Bars, wire, strip, billets	Valve parts	
		1.5.21		Bars, wire, strip, billets	Valve trim, pump shafts, bolts, nuts, valve seat rings	
		1.5.4, 1.5.23		Bars, wire, billets	Valves, valve trim, pump shafts	Also Type 303Se
		1.5.30		Bars, wire, billets	Bushings, needle valves, ball check valves	
		1.5.19		Bars, wire, strip, billets	Highly stressed parts	
		1.5.7		Bars, wire, strip, billets	Deep drawn parts, cold headed bolts and screws	
		1.5.24		Bars, wire, strip, billets	Needle valves, gears, shafts, cams	
		1.5.34		Bars, wire, strip, billets	Chemical process equipment	Type 443
		1.5.34		Bars, wire, strip, billets	Valves, valve fittings, piping	Type 329
		1.5.34	No. 20	Bars, strip, wire, billets	Agitating equipments, pumps, pump shafts and rods, valve parts	
			No. 20Cb	Tubing, pipe, sheet, plate strip, bars, billets, wire	Mixing tanks, process piping bubble caps, pickling tanks	
51	Carpenter Steel Co. Alloy Tube Div. Union, N. J.	1.5.5, 1.5.6, 1.5.8, 1.5.10, 1.5.11, 1.5.13–1.5.18, 1.5.21, 1.5.25, 19, 20		Tubing	Heat exchanger tubing	¼-in. to 4½-in. O.D.
		1.5.34	20Cb	Sheet, plate bar, tubing	Tanks, ducts, fume billets, hoods	20 Cr, 29 Ni
52	Celanese Corp. of America Newark, N. J.	24.13.2		Sheets, films, granules.	Linings	
		24.10	Fortiflex	Pellets	Pipe, valves, liners	
		24.15	Forticel	Granules	Pipe, valves, liners	Cellulose propionate
53	Chase Brass and Copper Co., Inc. Waterbury, Conn.	5.1.1	Electrolytic Tough Pitch Copper	Sheet, strip	Kettles	
		5.1.2	Doxidised Copper	Tube	Condenser, evaporator, and heat exchanger tube. Gas lines, gasoline supply lines, oil coolers, oil lines, and paper stock lines	
		5.1.3	Arsenical Copper	Tube	Condenser and heat exchanger tubes	
		5.2.2	Arsenical Admiralty	Tube, wire	Condenser, evaporator, heat exchanger and gas cooler tubes, filter screens	
		5.2.7	Red Brass	Tube	Condenser, evaporator, and heat exchanger tube, piping	
		5.3.1	Cupro-Nickel	Tube, sheet	Condenser, evaporator, and heat exchanger tube, piping	
		5.6.1	Silicon Bronze	Sheet, strip, rod, wire.	Evaporators, kettles, pickling tanks and baskets, tie rods, and filter screens	
54	Chemical and Power Products, Inc. New York, N. Y.	24.11.1	Chempro	Sheets, rods, cylinders, tubing, bars, tape	Packing, gaskets, mechanical seals, linings, expansion joints, special parts	
55	Chicago Gasket Co. Chicago, Ill.	24.11.1		Rods, sheets, tubing, cylinders	Gaskets, packing, seals	
56	Chicago Bridge and Iron Co. Chicago, Ill.	1.3.4, 1.3.5, 1.3.9, 1.3.10		Plates, sheets	Tanks, towers, digesters	
57	Ciba Products Corp. Kimberton, Pa.	24.5	Araldite	Liquid and solid resins	Pump impellers and castings	Casting resins
58	Cleveland Container Co. Cleveland, Ohio	24.1	Clevelite	Phenolic tubing		From 3/32 in. to 8 in.
59	Climax Molybdenum Co. New York, N. Y.	8		Bars, ingots, tubing	High-temperature applications	
60	Colonial Plastics Mfg. Co. Cleveland, Ohio	24.6.1, 24.6.2	Van-Cor	Pipe, tubes, pipe fittings, valves, sheet, rod, bar, custom fabrication and extrusions	Hoods, tank, duct work, custom fabrication of all types, bolts, nuts—custom machining	Pipe—¼ to 12 in.

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
61	Colorado Fuel and Iron Corp. Wilmington, Del.	1.3.9	.....	Plates and heads	Tank linings	
62	Columbia-National Corp. Cambridge, Mass.	19	.....	Sponge	Shafts, heat exchanger tubing, valves	Reactor and commercial-grade sponge
63	Connecticut Hard Rubber Co. New Haven, Conn.	25.7	Cohrlastic	Sheets, sponge, extrusions, moldings, fabricated parts	Gaskets, seals, ducts	
64	Cooper Alloy Corp. Hillside, N. J.	1.3.9 1.4.1–1.4.6	.....	Castings	Pump parts, valve parts, mixers	
		1.6.1–1.6.28	.....	Castings	Heat and corrosion resistant equipment	
65	Coors Porcelain Co. Golden, Col.	23.3	.....	Tubes, rods, bricks	Pump plungers, valves, ball mill liners, heat exchanger tubing and plates, rotary seals, grinding balls	
		23.6	.....	Tubes, rods, bricks		High alumina
66	Copolymer Rubber and Chemical Corp. Baton Rouge, La.	25.2	.....	Sheets	Linings, gaskets	
67	Corhart Refractories Co. Louisville, Ky.	23.5	Corhart Electrocast (Standard, Zac, 104)	Bricks, blocks, special castings	Furnace linings	Fused cast
68	Corning Glass Works Corning, N. Y.	23.1	Pyrex Brand	Sheet, tubes, castings, blown ware, pressed	Piping, fittings, heat exchangers, columns valves, trays, gage glasses, sight glasses, tubing	Borosilicate glass
		23.2	Corning Brand	Sheets, plates, crucibles, optical windows		
		23.6	Pyroceram Glass-Ceramics	All forms	New material—custom built	
		23.2	Vycor Brand	All forms	Trays, tubing, crucibles, sight glasses, sheet, special shapes	96% Silica
		23.1	Corning Brand	Plate	Hot cell windows	Lead glass
		23.1	Corning Brand	Flat, blown, pressed, drawn	Flat tempered guage and sight glasses	Lime glass
69	Crane Packing Co. Morton Grove, Ill.	24.11.1	Chemlon	Sheet, rod, tubing, tape, stock, custom molded or machined parts, compounds	Valve or pump packings, hydraulic cylinder packing, gaskets, shaft seals for pumps, agitators, mixers, pipe thread or gasket sealing compound	
70	Crucible Steel Company of America Pittsburgh, Pa.	1.1.1	Crucible	Pigs and bars		
		1.2.1, 1.2.2	Maxelloy	All forms but tubing, bricks and blocks	Bolts and nuts, skips, hoppers, freight cars, pumps, coke quenching cars, pump parts, silos	
		1.4.1–1.4.6	Crucible	All forms but tubing, bricks and blocks	Non-corrosive applications, oil and gas industry, dairy equipment, appliances	
		1.5.1–1.5.34	Crucible	All forms but bricks and blocks	Non-corrosive applications, heat exchangers, aircraft, dairy equipment, building	Pipe and tubing ⅛ to 48 in.
		1.6.1–1.6.28, 1.7..	Accumet and Crucast	Cast to specs	Aircraft parts, non-corrosive applications, valve parts, sand-shell-precision investment	
		1.4.6	Ferro-Vac 4340	Vacuum melted—all forms	Gears, pinions, shafts and pins for critical applications, bolts, screws, aircraft structural parts	
		1.4.6	Ferro-Vac Halmo	Vacuum melted—all forms	Hot work tool steel, bearings for high-temperature applications	
		14.1–14.4	Crucible Ti	All forms	Aircraft parts, chemical industry valves, missile parts, nautical components	Formerly Rem-Cru Titanium

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
71	Curtis Wright Corp. Metals Processing Div. Buffalo, N. Y.	1.4.1–1.4.6, 1.5.5, 1.5.14		Tubes, extruded shapes	High-pressure piping systems	10–20-in. O.D.
72	Denver Equip. Co. Denver, Colo.	1.1.1	Decoloy	Castings	Pump impellers, ball mill linings, filter bodies	
		1.2.2		Castings	Ball mill heads, crusher frames	
		1.4.4, 1.4.6		Castings	Ball mill liners	
73	Diamond Alkali Co. Cleveland, Ohio	24.6.1, 24.6.2		Resin	Linings, pipe	
74	Dow Chemical Co. Midland, Mich.	24.6.3	Saran	Sheets, rods, cylinders, blocks, discs, tubes	Piping, valves, fittings	Lined iron pipe
		24.6.3	Saraloy	Sheets	Tank linings, gaskets	
		24.5, 24.8, 24.10		Resin powder	Linings, piping systems	
		9		Ingots		
75	Dow Corning Corp. Midland, Mich.			Solution	Laminating resins for structural and electrical components serviceable at temperatures around 500F.	59% silicone resin solution
		24.12		Dry resin	Molding compound for compression or transfer molding of structural and electrical components serviceable at temperatures to 900F	Glass fiber reinforced
				Powders	Foamed structures for high-temperature applications	
		25.7	Silastic	Fully compounded silicone rubber stocks and pastes	Gaskets, seals, O-rings, ducts, electrical insulation and other applications requiring rubber parts for service temperatures from 130 to 500 F.	
76	Duraloy Company Scottdale, Pa.	1.6.1–1.6.28		Static cstgs, centr. cast tubing, shell mold cstgs.	Pump impellers, casings, valve trim, gas reformer tubing	
77	Durethene Corp. Chicago, Ill.	24.1	Durethene	Tubular	Pipe	
78	Duriron Co., Inc. Dayton, Ohio	1.1.3	Duriron	Castings	Pipe fittings, heat exch. parts, pump parts, valve parts, exhaust fan parts, drain p pe	
		1.1.3 1.6.14 10.3 10.5 1.6.6 1.6.10	Durichlor Durimet 20 Durco D-10 Chlorimet Durco 18-8S Durco 18-8SMo	Castings	Pump parts, valve parts	
		24.5	Durcon	Castings	Valve parts, sink strainers, laboratory sinks, pump parts	
		1.1.4	Durco Ductile Iron	Castings	Pump parts, valve parts	
		1.6.6 1.6.10 1.6.14	Durco 18-8S Durco 18-8SMo Durimet 20	Fabrications	Filtration equipment	
79	E. I. du Pont de Nemours and Co. Wilmington, Del.	25.4, 25.8		Sheets	Gaskets, linings	
		25.9		Sheets	Gaskets, linings	Fluorocarbon rubber
		24.7, 24.9, 24.10, 24.11.1		Resin	Molded products, piping, linings	
		14.1		Ingots	Valves, pipe, reactors	
80	Eastern Stainless Steel Co. Baltimore, Md.	1.5.1, 1.5.2, 1.5.4–1.5.8, 1.5.10, 1.5.12–1.5.18, 1.5.21, 1.5.25, 1.5.31		Sheets, plates, coils, strips	Furnace parts, heat exchanger tubing, reactor shells, filters	
		1.5.34		Sheets, plates, coils strips		Types 318, 330, 348, 442, 201, 202, A286
81	Eastman Chemical Products, Inc. Kingsport, Tenn.	24.10 24.13.3 24.13.2 26	Tenite Polyethylene Tenite Butyrate Tenite Acetate Tenite Propionate	Pellets	Piping, valves, liners	
82	Easton Plastic Products Co., Inc. New York, N. Y.	24.6.1, 24.6.2	Easton	Tubular	Piping systems	

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
83	Eimco. Corp. American Foundry and Machine Div. Salt Lake City, Utah	1.1.1		Castings	Valves	
		1.1.7		Castings	Ball mill liners, conveyor flights	High Cr, Mo. iron
		1.4.4	Utaloy 700	Castings	Ball mill liners, screw conveyor flights	
		1.4.6		Castings	Impeller bars. High-temp. application	Austenic Ni-Cu
84	Electric Steel Foundry Co. Portland, Ore.	1.6.1, 1.6.3, 1.6.4–1.6.10, 1.6.12, 1.6.13		Castings	Valves, fittings, pipe	
		1.7		Castings	Valves, fittings, pipe	Ni-Resist, Monel, Inconel, Hastelloys, 17-4PH
85	Electro Chemical Eng. and Mfg. Co. Emmans, Pa.	25.5	Buta-Bond	Sheet	Tank linings	
	Electro Refractory and Abrasives Corp. Buffalo, N. Y.	23.5	Kellogg AA	Bricks	Furnace linings	Silicon carbide
			Tercod	Tile	Furnace linings	Silicon carbide
			Kellundite	Brick, tile	Furnace linings	Fused alumina
87	Empire Steel Castings, Inc. Reading, Pa.	1.6.1–1.6.28		Castings	General	
		1.7	ISO-40	Castings	Valve and pump components, nozzles, screws	
		10.3	ISO-31	Castings	Pump components and general	
		10.5	ISO-32			
		1.7	ISO-35			
88	Enjay Co. New York, N. Y.	25.5	Enjay Butyl		Chemical hose, conveyor belts, gaskets, seals, O-rings, linings	
89	Escambia Chemical Corp. New York, N. Y.	24.6.1, 24.6.2		Pearls, powder	Linings, pipe, valves	
90	Falls Industries, Inc. Solon, Ohio	22.4	Impervite	Sheets, plates, rods, bars, tube block	Heat exchangers (tubes, plates, cylinders, domes, shells), towers, pumps (seals, volute case assemblies, impellers), pipe, fittings	
91	Fansteel Metallurgical Corp. North Chicago, Ill.	12		Sheet, tubing, rod, wire	Heat exchangers, heating and cooling coils, evaporators, liners for reactors	
		13				
		8		Sheet, tubing, rod, wire, extrusions, forgings	Tubing, forgings, and other parts for high-temperature, corrosion service	
		16		Plate, sheet, rod, sintered parts	High-temperature parts, parts for radioactive shielding	
		16	77 Metal	Sintered parts	High density material for counterweights and radioactive shielding	
92	Filtros Inc. East Rochester, N. Y.	23.2, 23.3		Plates, cylinders, porous disks	Nutsche filters, catalyst carriers, gas dispersion units, diffuser media	Quarts, carbon, fused alumina, muillite
93	Firestone Plastics Co. Pottstown, Pa.	24.6.1, 24.6.2, 24.6.4	Exon	Sheets, plates, rods, castings	Valve bodies, tank linings, gaskets	
94	Firestone Tire & Rubber Co. Akron, Ohio	25.1.2, 25.2, 25.3		Sheets	Linings, gaskets	
95	Firth Sterling Inc. Pittsburgh, Pa.	19		Ingot, billet, hot and cold rolled strip, round bar	Process piping, tank linings, valves, fittings	
96	Fluoro Plastics Inc. Philadelphia, Pa.	24.11.1	Teflon	Tape, sheet, rod, tube, special shapes	Gaskets, packing seals, pump and valve packing	
		24.11.2	Kel-F			
97	Frontier Bronze Corp. N. Falls, N. Y.	2.18	40E		Ventilating fans, engine and compressor pistons	5.4% Zn, 0.5% Mg 0.58% Cr, 0.18% Ti
98	Furane Plastics, Inc. Los Angeles, Calif.	24.5	Epocast	Liquid	Linings, for tanks, agitators	
		24.15	Jet-Kote	Liquid	Linings for fume ducts, filter presses	Baked furane

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
99	Garlock Packing Co. Palmyra, N. Y.	24.9, 24.11.1, 24.11.2, 24.11.3.	.....	.....	Gaskets, tubing, molded and extruded shapes	
		25.1.2, 25.2, 25.4..	.....	.....	Gaskets, tubing, molded shapes	
		25.3, 25.5, 25.7, 25.9.....	.....	.....	Oil seals, gaskets, tubing, molded shapes	
100	Garlock Packing Co. United States Gasket Co. Camden, N. J.	24.11.1.....	Chemiseal.....	Sheets, tape, rods, tubing, bars, cylinders, custom molded parts	Hopper, chute, mixer and other equipment linings, work surfaces, bearings, gaskets, mechanical packings	Anti-stick qualities, non-contaminating, low coefficient of friction, anti-corrosion qualities
		24.11.2.....	Chemiseal.....	Sheets, discs, film, rods, tubing, custom-molded parts	Tank and vessel linings, mechanical packings, gaskets	Heat sealed linings, resistant to most chemicals
		24.9.....	Chemiseal.....	Tubing, rods, film, slab, custom-molded parts	Pressure tubing-equipment components	1,000 psi. and 2,500 psi., heat stabilised tubing
101	Gates Engineering Co. Wilmington, Del.	24.6.1, 25.4, 25.8, 25.1.1, 25.1.2...	Gaco.....	Sheet, liquid.....	Tank linings	
102	General Alloys Co. Boston, Mass.	1.6.1–1.6.28.....	.....	.....	Pumps, valves, filter plates, piping, fittings, impellers, sluice gate parts, digester parts	Also fabricate 1.5.4–1.5.34
		10.1.....	Cast Nickel.....	Castings.....	Pump parts	
103	General Electric Chemical Materials Dept. Pittsfield, Mass.	23.6.....	.....	Granular.....	Refractories	
		24.1, 24.4, 24.15	.....	Powder, Solution, Resins.....	.....	Polycarbonate resins
	Metallurgical Products Dept. Detroit, Mich.	16,23.6.....	Carboloy.....	Blanks.....	Wear and corrosion resistant parts	
		10.3.....	J-1300, 1500, 1570, Rene 41.....	Plate, bar, ingot.....	Corrosion and heat resistant parts	
104	General Electric Co. Plastics Dept. Decatur, Ill.	24.1–24.9, 24.11.2, 24.11.3, 24.12, 24.13.2, 24.13.3, 24.14, 24.15, 25.7.....	.....	Custom moldings		
105	General Electric Co. Silicone Products Waterford, N. Y.	24.12, 25.7.....	.....	Silicone resins, rubber compounds.....	Tubing, insulation,	
106	General Rubber Corp. Tenafly, N. J.	21.....	Genbestos.....	Sheets.....	Gaskets	
		25.1.1, 25.1.2, 25.2–25.9.....	.....	Sheets.....	Linings for tanks, valves	
107	General Tire & Rubber Co. Bolta Products Div. Lawrence, Mass.	24.6.1.....	Boltaron.....	Sheets, bars, tubes, blocks.....	Tanks, ducts, fans, nuts,	
		24.6.2.....	Boltaron			
		24.10.....	Boltathene	Sheet.....	Tanks, ducts	
		25.2.....	Boltaron			
108	General Tire & Rubber Co. Chemical Div. Akron 9, Ohio	24.14.....	Benthane-S.....	Rubber-like gum		
		24.6.1, 24.6.2.....	Vygen.....	Resins, powders.....	Piping, valves, liners	
109	Goldsmith Bros., Smelting and Refining Co. Chicago, Ill.	7.1, 7.4, 7.6.....	.....	Pigs.....	Equipment linings	
		11.1–11.5.....	.....	Wire, sheets, foil.....	Tank linings, pipe, impeller blades	
110	Goodall Rubber Co. Trenton, N. J.	25.2, 25.3, 25.5 25.1.1, 25.1.2	.....	Sheets, tubular.....	Linings, gaskets	
111	B. F. Goodrich Chemical Co. Cleveland, Ohio	24.6.1.....	Geon.....	Powder, liquid, sheet..	.....	Thermoplastic materials used for extrusion, molding, casting, coating, and calendering
		25.2.....	Hycar.....	Powder and latex.....	Resin.....	Thermoplastic
		25.3.....	Hycar.....	Crumb, powder, slabs, latex.....	Rubber elastomer.....	Special purpose rubbers
		25.5.....	Hycar.....	Slab.....	Rubber elastomer.....	Special purpose rubbers
		25.9.....	Hycar.....	Slab and latex.....	Rubber elastomer.....	Acrylic copolymer
112	B. F. Goodrich Industrial Products Akron, Ohio	25.1.1, 25.1.2, 25.2–25.5, 25.8.	.....	Sheets.....	Tank lining	
		24.6.1, 24.6.2.....	Koroseal.....	Sheets, bars, tubes....	Pipe, fume ducts	
		24.6.4.....	Koroseal.....	Sheets.....	Tank lining	

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
113	Goodyear Tire & Rubber Co. Akron, Ohio	25.1–25.5, 25.9...	Plioweld Lining.....	.....	Tank lining, pump lining	Factory applied
		25.1.1, 25.1.2, 25.2	Armadillo.....	Sheets, slabs.....	Chute and trough lining tanks, pumps, impellers	
		25.1–25.4.....	Armaplate.....	Sheets.....	Chute and trough lining tanks, pumps, impellers.....	Rubber lining bonded to sheet steel
		25.1,–25.5, 25.8, 25.9.....	.....	Sheets, slabs.....	Gaskets, packing	
		24.6.1.....	Pliovic.....	Resins.....	Gaskets, hose, tubing	
		25.2.....	Plioflex	Bales.....	Gaskets, tubing, O-rings, seals, grommets	
		25.3.....	Chemigum	.....	.....	Oil and fuel resistant
114	Goslin-Birmingham Mfg. Co. Birmingham, Ala.	1.1.1, 1.1.2, 1.1.7..	.....	Castings.....	Autoclaves, kettles, filters, towers	
		1.2.2, 1.4.1–1.4.6..	.....	Castings.....	Pump casings, autoclaves, pump impellers, miscellaneous castings	
115	W. R. Grace and Co. New York, N. Y.	24.2.....	.....	Crystals.....	Plastic molding compounds	
		24.6.3.....	.....	Sheet film.....	Insulating material	
		24.10.....	Grex.....	Pellets.....	Insulating materials, pipe, tubing	
116	Graphite Specialties Corp. Niagara Falls, N. Y.	22.1, 22.2.....	.....	Rods, tubes	Heat exchangers, cascade coolers, evaporators high temperature furnaces, chlorine heaters, etc.....	
		22.3.....	Carbo-Tite	Rods, tubes		
		22.4.....	Graph-I-Tite			Impervious without the use of resins
117	Great Lakes Carbon Corp. New York, N. Y.	22.1, 22.2.....	.....	Rounds, blocks, bricks	Tank and furnace linings, electrolytic cells, nuclear reactors	
118	Grinnell Co., Inc. Providence, R. I.	24.6.3.....	.....	Tubing, piping.....	Piping systems, valves	
119	Handy and Harman New York, N. Y.	11.1, 11.2, 11.3, 11.5, 11.6.....	.....	Sheet, plate, rod, tube, wire.....	Tank lining, tubes, gaskets	
120	Harbison-Walker Refractories Co. Pittsburgh, Pa.	23.5.....	.....	Brick, castables, blocks	High-temperature lining	
121	H. N. Hartwell and Son, Inc. Boston, Mass.	24.6.1.....	Boltaron 6200.....	Tubular, sheets, blocks, bars.....	Piping systems, valves, tanks	
		24.6.2.....	Boltaron 7200.....	Tubular, sheets.....	Pipe, tank linings	
122	Harvey Aluminum Torrance, Calif.	2.1–2.18.....	.....	Rod, bar, pipe, tube, hollow sections, forging stock, impact extrusions, structural, special shapes	Aluminum tubing and pipe for piping, heat changers, aluminum impact extrusions for AEC applications, hydraulic lines and fittings, aluminum forgings	
		14.1–14.4.....	.....	Extrusions, forgings, castings.....	Titanium forgings for valve bodies, fittings. Ti extrusions for heat exchangers and piping of special fluids	
		19.....	.....	Extrusions, forgings...	Valve bodies, fittings, piping	
		1.4.1–1.4.6, 1.5.1–1.5.34.....	.....	Extrusions.....	Structural applications	
123	Haveg Industries Inc. Wilmington, Del.	24.1.....	Haveg 31, 41			
		24.4.....	Haveg 7710	Sheet, rod, tube, pipe, fittings valves.....	Tank linings, structural parts	
		24.11.1.....	Haveg TeFlos			
		24.15.....	Haveg 61, 93			
124	Heil Process Equipment Corp. Cleveland, Ohio	22.4.....	Nocordal.....	Tubes.....	Heat exchangers	
		24.4.....	Rigidon.....	Sheets, ducts, shapes..	Ventilating ducts, fume scrubbers, fans, hoods, tanks	
125	Hercules Powder Co. Wilmington, Del.	24.10.....	Hi-fax.....	Molding powder.....	Piping systems, valves	
		24.15.....	Pro-fax.....	Molding powder.....	Piping systems, valves.	Polypropylene
		24.15.....	Penton.....	Molding powder.....	Injection molded valves, fittings and pump parts, extruded rod, tube and pipe	Chlorinated polyether

Materials of Construction

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
126	Heresite & Chemical Co. Manitowoc, Wisc.	24.1 25.3 25.9	Heresite M-66 Hereeol N-40 RC-9	Molding powders Crepe Liquid	Small pump parts Tank linings, gaskets Tank linings	 Crepe is compounded Self-curing
127	Hooker Chem. Corp. Durez Plastics Div. Tonawanda, N. Y.	24.1 24.4	 Hetron	Powder Powder	Agitators, pumps, valves Tanks, duct work, structural parts	
128	Houghton Laboratories Inc. Olean, N. Y.	24.4	Hysol	Sheet, rod, tube	Tank linings, piping	
129	Illinois Clay Products Co. Joliet, Ill.	23.5	Goose Lake Firox Grundite Chem-Brix	Brick Castable Clay Brick	Linings, furnace walls, high-temperature construction	
130	Industrial Plastic Fabricators, Inc. Norwood, Mass.	24.6.1, 24.6.2, 24.4, 24.5, 24.10		Sheets and rod	Tank linings	
131	International Nickel Co. New York, N. Y.	10.1 10.2 10.3 20 20	Inco Monel Inconel Incoloy Nionel	Sheets, plates, rods, bars, tubular, wire, forgings, castings	Autoclaves, dryers, piping, evaporators Stills, evaporators, fans, valve trim Evaporators, fermentation tanks, heaters 	 "S" Monel-cast form Fe-Ni-Cr alloy Ni-Fe-Cr alloy
132	The Ironton Fire Brick Co. Ironton, Ohio	23.5	Pavers Peerless AL-70	Brick Brick Brick	Acid tank linings, pickling tanks Furnace linings Lime and cement kiln linings	
133	Jenkins Bros. New York, N. Y.	1.5.14 1.5.34	 J-20	Castings Castings	Valves Valves	A.C.I. CF-7M A.C.I. CN-7MCU
134	Johns-Manville New York, N. Y.	21 23.5 21	Transite	Pipe Brick Sheet	Piping systems Furnace linings Gaskets, packings	
135	Jones and Laughlin Steel Corp. Pittsburgh, Pa.	1.2.1, 1.4.1, 1.4.3–1.4.6 24.6.1 24.10	 Jal-Jacket Jalboy	Sheets, rods, wire, bars Pipe 	Heat exchangers, tanks, columns, pumps Piping systems 	 Steel-jacketed PVC pipe Polyethylene bottles
136	Jones and Laughlin Steel Corp. Stainless and Strip Div. Detroit, Mich.	1.5.1–1.5.34 1.4.1–1.4.6	 Bars, billets	Bars, wire, billets, sheets, strip		Sheet and strip not produced in 1.5.4, 1.5.23, 1.5.28, 1.5.30
137	Jessop Steel Co. Washington, Pa.	1.3.5, 1.3.9 1.4.1–1.4.5 1.5.1, 1.5.2, 1.5.4–1.5.12, 1.5.14–1.5.18, 1.5.21 1.5.23, 1.5.24 1.5.25 1.5.28–1.5.31 1.6.6., 1.6.7, 1.6.9–1.6.13, 1.6.25	 	Bars, sheets, plates Bars, sheets, plates Bars, sheets, plates Bars only Bars, sheets, plates Bars only Castings	Reactors, heat exchangers, columns Chemical equipment Crystallisers, heat exchanger, columns Pumps, valves	
138	Kaiser Aluminum and Chemical Sales, Inc. Chicago, Ill.	2.1, 2.3, 2.4, 2.6–2.13 2.14–2.17 23.5	 	Sheet, plate, foil, wire, bar, rod, forgings Castings Brick, ramming mixes	Heat exchangers, tanks Valves, pump components, fittings Furnace and kiln linings, high-temperature construction	 Periclase (MgO), chromite
139	Kawecki Chemical Co. New York, N. Y.	12, 13		Sheets, plates, rods, bars, tubes, wire, foil	Evaporator bodies, pump impellers, heat exchangers	
140	Kaykor Industries, Inc. Yardville, N. J.	24.6.1, 24.6.2 24.6.4 24.6.1 24.6.4	 Vyflex L-10 Fligid Vyflex L-15	Sheets, plates Sheets, rolls Sheets, rolls Sheets, rolls	Exhaust ducts, stacks, hoods, pumps, fans, custom fabricated items Tank lining, membranes Tank lining Gasketing in corrosive environments	

	MANUFACTURER	MATERIAL	TRADE MARK	FORMS	APPLICATIONS	REMARKS
141	Kearney Industries, Delanium Graphite Div. Elizabeth, N. J.	22.1–22.4	Delanium		Condenser bodies, evaporator bodies, heat exchanger bodies, rupture discs, rupture disc holders, safety valve liners, pump casings, pump impellers	
142	Keasbey and Mattison Co. Ambler, Pa.	21		Pipe	Water pressure systems	Asbestos-cement pipe
143	Kennametal Inc. Latrobe, Pa.	12		Bars, sheets, rods, wire, foil	Heat exchangers, bayonet heaters, tank linings	Tungsten and titanium carbides
		23.6	Kennametal and Kentanium	Rods, bars, tubes, discs, blocks, blanks, pressings, metal powder, extrusions	Liners, crusher components, scraper blades, nozzles, wear strips, pumps impellers	
144	Knapp Mills, Inc. Long Island City, N. Y.	7.1–7.6		Sheets, brick	Tank linings, radioactive shielding	
145	Maurice A. Knight Co. Akron, Ohio	23.3–23.6	Knight-Ware		Pipe, jars, filters, sumps, towers, tower packings, tanks, valves	
		25.9	Pyroflex	Sheets	Tank linings	
		24.6.4	Sealon	Sheets, tubes	Tank lining, pipe	Plastisized and rigid vinyl
		26	Macron	Sheets	Tank linings	
		27	Permanite		Pipe, towers, tanks, valve bodies, tower packing	Furan resin
146	Koppers Co. Pittsburgh, Pa.	24.10	Dylan	Molding powder	Pipe fittings, pipe	
		24.8	Dylite	Molding powder	Pipe, molded products	
147	Kraloy Plastic Pipe Co., Inc. Los Angeles, Calif.	24.6.1, 24.6.2		Pipe	Piping systems	
148	Kurtstown Foundry and Machine Corp. Kurtstown, Pa.	1.1.1, 1.1.2, 1.1.4		Castings	Pumps, tanks, valves heavy equipment	
149	La Favorite Rubber Co. Hawthorne, N. J.	25.1.2–25.9		Sheets	Tank linings	
150	Lebanon Steel Foundry Lebanon, Pa.	1.2.2, 1.4.1–1.4.6, 1.6.1–1.6.28, 4.2, 10.1–10.6	Circle (L) and Ceramicast	Castings	Pump impellers and casings, valve trim and bodies, agitator blades evaporator bodies, screw conveyor flights	Circle (L)—Sand castings up to 7,000 lb. Ceramicast—close tolerance castings from ceramic molds; up to 300 lb.
151	Lapp Insulator Co., Inc. Process Equipment Div. Le Roy, N. Y.	23.3		Tubular, castings	Tower packing, corrosion, resistant valves, pipe, special shapes	
		23.3	Tufclad	Tubular, castings	Pipe, and valves	Fiberglass and epoxy resin armor
152	Leader Iron Works, Inc. Decatur, Ill.	1.2.1, 1.3.4–1.3.6, 1.3.9, 1.5.5, 1.5.6, 1.5.14–1.5.18, 2.1, 2.2, 5.1.1, 5.1.2, 5.6.1, 10.1–10.3		Plates, sheets	Tank linings, evaporator bodies, autoclave bodies, heat exchangers, fractionating column shells and trays	
153	Libbey-Owens-Ford Glass Co. Toledo, Ohio	1.3.2	Tufflex	Sheets	Equipment linings, tanks, columns	
		23.1	Vitrolux	Sheets		
154	Libbey-Owens-Ford Glass Fibers Co. Toledo, Ohio	23.1, 23.2		Fibers	Reinforced plastics	
155	Linatex Corp. of America Stafford Springs, Conn.	25.1.2	Linatex	Sheets	Pumps, valves, tank linings, agitator blades, ball mill liners	
156	Link-Belt Co. Chicago, Ill.	1.1.4	Promal	Castings	Pump casings, gears	
157	Logan Clay Products Co. Logan, Ohio	23.6	Logan	Tubes and pipe	Drains, sewers	4 to 36-in. dia.

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
158	Los Angeles Steel Casting Co. Los Angeles, Calif.	1.2.2, 1.4.1–1.4.6, 1.6.1–1.6.28	.....	Castings	Made to customers' blueprints	
159	Lukens Steel Co. Coatesville, Pa.	1.2.1	.....	Plates		
		1.3.1,1.3.4–1.3.6, 1.3.9	.....	Plates	Tube sheets, heat exchangers, tanks, pressure vessels, columns, kettles, evaporators, etc.	
		1.3.10	.....	Plates	Process equipment	Hastalloy and clad steel
		1.3.10	.....	Plates	Tube sheets, heat exchangers, tanks, pressure, vessels, columns, kettles, evaporators	Cupro-nickel clad steel
		1.4.1, 1.4.4	.....	Plates	Pressure vessels for high temperature	
		1.4.2	.....	Plates	Pressure vessels and tanks for low temperature	
		1.4.6	.....	Plates	Pressure vessels	
160	Luserne Rubber Co. Trenton, N. J.	24.6.1	.....	Sheet, rod, tube, custom moldings	Pipe, fittings, valves, linings, roll coverings, molded equipment	
		24.6.2, 25.1.1, 25.3	.....	Farbications		
		24.7-24.10	.....	Custom moldings		
161	Mallory-Sharon Metals Corp. Niles, Ohio	14.1	.....	All mill shapes	Tower packing, pall rings, pump impellers, heat exchangers, tank linings, chlorine dioxide mixers	
		14.4	MST-6A1-4V	All mill shapes	High strength alloy for elevated temperature and/or pressure	
		19	.....	All mill shapes	Pump impellers valves, heat exchangers, tower packing pall rings, autoclave bodies, tank linings	Atomic reactor grade, commercial grade, Zircaloy-2
162	Mannesmann-Easton Plastic Prod. Co., Inc. Easton, Pa.	24.6.1, 24.6.2	Easton	Pipe, tubing, rod stock	Piping systems	
163	McDanel Refractory Porcelain Co. Beaver Falls, Pa.	23.3, 23.5	.....	Tubing, bricks	Mill, furnace linings, insulators, combustion tubes	
164	McLouth Steel Corp. Detroit, Mich.	1.5.1	.....	Sheet, strips	Beer fermenters	
		1.5.2, 1.5.3	.....	Sheet, strips	Strainers, screw conveyors	
		1.5.5	.....	Sheet, strips	Heat exchangers, vats	
		1.5.6-1.5.21	.....	Sheet, strips	Large-section welded tanks	
		1.5.25	.....	Sheet, strips	Impellers	
		1.5.26	.....	Sheet, strips	Heat exchangers	
		1.5.31, 1.5.32	.....	Sheet, strips	Burner parts	
		1.5.33, 1.5.34	.....	Sheet, strips	Fractionating tower shelves and bubble caps	
165	Metals and Controls Corp. General Plate Div. Attleboro, Mass.	3	.....	Foil, strip		
		11.1–11.6	.....	Foil, strip, wire, (including thermocouple wire), tubing, gauze —solid and clad with base metal	Equipment lining, catalyst	
		12, 14.1, 17	.....	Foil, strip		
		19	.....	Rod, wire, foil, coils, strip		
166	Midvale-Heppenstall Philadelphia, Pa.	1.2.1, 1.4.1, 1.4.6, 1.5.1–1.5.34, 10.1–10.6, 16, 17	.....	Forgings	Valve bodies, crusher rolls, autoclave bodies	
167	Minnesota Mining and Manufacturing Co. St. Paul, Minn.	24.11.2	Kel-F(R)	Molded and extruded parts	Tank linings, agitators.	Dispersions
		24.11.2	Kel-F(R)	Bulk-plastic powder	Valves, "O" rings, pump diaphragms	
		24.5	Scotchply	Rolls, sheets	Piping, tanks, chemical equipment	
		24.1	Scotchply	Rolls, sheets	Piping, tanks	Phenolic-asbestos, phenolic-nylon
		25.9	Kel-F(R)	Bulk, solid rubber, molded and extruded parts	Pumps, valves, plating component	Elastomers

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
168	Modular Plastic Corp. Detroit, Mich.	24.4, 24.5	Polyglas	Sheets, castings, tubular, moldings	Tanks, tank linings, pipe, ducting, absorption towers, scrubbers	Fiber-reinforced, also bonded to steel
169	Monsanto Chemical Co. St. Louis, Mo.	24.6.1, 24.6.2 24.1, 24.4, 24.10	Opalon —	Resin powder Resin powder	Linings, piping systems	
170	Mueller Brass Co. Port Huron, Mich.	1.2.1	—	Powder compacts, fabricated products	Tees, valve bodies, valves, stems, dehydrators	
		2.1	—	Impact extrusions, sheet extrusions	Adaptors, tubes, cans, diaphragms, cases, special fabricated components	
		2.4., 2.8, 2.9, 2.10	—	Sheet	Special fabricated components	
		2.12, 2.14	—	Impact, extrusions	Adaptors, cans, cases, tubes	
		5.1.2	Alloy 214A	Tube, fittings, bends, special forms	Plumbing, heat exchanger coils and bends, manifolds, heat exchangers	
		5.1.4	Alloy 799	Rod, bar	Machined fittings and special parts	
		5.2.6	Alloy No. 203	Rod, bar	Valve components	
		5.2.7	Alloy No. 705	Rod, tube	Plumbing, valve stems, special parts	
		5.2.9	Alloy No. 200, 201	Rod, forgings, machined parts	Valve bodies, stems, fittings, valves, hardware, nuts, liquid indicators	
		5.2.10, 5.2.12	Alloy No. 790	Rod	Hardware, machine hardware, rivets, screws	
		5.2.14	Alloy No. 600, 603	Rod, bar, forgings, machined parts	Bearings, gears, stems, connecting rods, shafts, rings	
		5.3.3	Alloy No. 515	Rod, forgings, machined parts	Stems, valve bodies, chlorine valve bodies	
		5.5.2	Alloy No. 802	Rod, forgings, machined parts	Valve stems, valve bodies, chlorine valve bodies, valve seats, gears, marine hardware	
		5.5.3	Alloy No. 224E, 224C, 224K	Rod, forgings, machined parts	Valve stems, gears, bearings, rings, valve seats, guides, rollers, collars, cams	
		5.7	Alloy 217	Sand castings	Plumbing fittings, valve bodies	
		5.4.2	Sinteel porous bronze, sinteel bronze bearings	Powder compacts	Filters, bearings, bushings	
		24.6.1, 24.6.2 24.10	— —	Pipe and fittings Tube	Chemical plumbing Chemical plumbing, water plumbing	
171	National Distillers and Chem. Corp. U. S. Industrial Chemicals Co. Div. New York, N. Y.	24.10	Petrothene	Flakes	Piping, lining	
172	National Lead Co. New York, N. Y.	1.3.3, 7.1–7.6	—	Sheets, plates, tubular	Tank linings, piping, valve bodies, pump impellers, heat exchanger tubing, evaporator bodies, autoclave bodies, agitator blades	
173	National Steel Corp. Weirton Steel Co. Div. Weirton, W. Va.	1.3.10	Weirsin	Sheets	Tubing, tanks	Zinc coated steel
174	New Jersey Zinc Co. New York, N. Y.	18 18 18	— Horse Head Zamak Zilloy	Slabs Ingots Rolled strip	Linings, casting forms	
175	North American Refractories Co. Cleveland, Ohio	23.5	—	Brick	Furnaces, boilers, rotary kilns, metallurgical furnaces, heating and annealing furnaces, checkers and checker chambers	
176	Northwest Lead Co. Seattle, Wash.	7.1–7.6	Bunker Hill	Sheets, bars, tubing, wire, castings, bricks	Agitator blades, tank linings, tanks, piping	

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
177	Norton Co. Worcester, Mass.		Alundum	Bricks, blocks, tubes, cements	Reactor linings, heat exchangers, furnaces	Alumina
			Crystolon	Bricks, blocks, plates, tubes	Furnaces, dust collectors, retorts	Silicon carbide
		23.5	Crystolon N	Bricks, blocks, plates, tubes	Chemical fusion furnaces, retorts, aluminum melting	Nitride bonded silicon carbide
				Bricks, blocks, plates, tubes	Heat exchangers, air heaters, chemical reactors	Stabilized zirconia
			Magnorite	Bricks, blocks, plates, tubes	Fusion furnaces, metal melting	Magnesia
		23.6		Lumps, screened material	Refractories, cermets	Borides, carbides, nitrides, oxides
178	Ohio Steel Foundry Co. Springfield, Ohio	1.4.1–1.4.6, 1.6.1–1.6.28	Fahrite	Castings	Corrosion resistant in all cast forms, fittings, return bends	
179	Owens-Illinois Glass Co. Toledo, Ohio	1.3.2, 23.1		Sheets	Equipment linings	
180	Owens-Corning Fiberglas Toledo, Ohio	23.1		Fibers	Reinforced plastics	
181	Oregon Metallurgical Corp. Albany, Oregon	7.1–7.6		Ingots, vacuum cast shapes	To customers specifications (valves, pumps, etc.)	
		8		Ingots		
		14.1, 14.2, 14.4, 19		Ingots and castings		
		14.3		Ingots only		
		17		Ingots		
		20		Ingots, castings		
182	Pacific Foundry Co. Ltd. San Francisco, Calif.	1.1.1		Castings	General castings	
		1.1.2	Niresist	Castings	Pump and valve parts, filter screens	
		1.1.3	Corrosiron	Castings	Pipe and fittings, pumps, valves, fans	
		1.6.6., 1.6.7, 1.6.10, 1.6.12, 1.6.19, 1.6.20, 1.6.22		Castings	Pump parts, valves, chemical equipment, castings	
183	Patterson Foundry and Machine Co. East Liverpool, Ohio	23.3	Porox	Balls, blocks	Grinding media, tank linings, ball mill linings, mixer linings	
		23.6	Aricite	Balls, spheres, blocks, special shapes	Grinding media, tower packing, ball mill linings, screw conveyor liners, chute linings, discharge nozzles, disintegrator blades	
184	Pfaulder Co. Pfaulder-Permutit Inc. New York, N. Y.	1.3.2	Glasteel	Complete fabricated units	Reactors, storage tanks, heat exchangers columns, dryer blenders, pipe, valves and fittings	Glass fused to steel by high-temperature firing
185	Phelps Dodge Copper Products Corp. New York, N. Y.	5.1.1–5.1.4		Tubular	Radiators, heat exchanger tubing	
		5.2.1–5.2.7, 5.2.9, 5.2.10, 5.2.13, 5.2.14, 5.3.1, 5.4.2, 5.5.1		Tubular	Distiller and heat exchanger tubing, steam and water lines, marine hardware, plumbing accessories	
186	Phillips Chemical Co. Bartlesville, Okla.	24.10	Marlex	Pellets	Tank linings, pipe wrap, metal coating, chemical containers	
187	Phoenix Iron and Steel Co. Steel Tube Div. Phoenixville, Pa.	1.2.1		Tubing, pipe	Heat exchanger tubing	
188	Pittsburgh Corning Corp. Pittsburgh, Pa.	23.1	Foamglas	Blocks, tubular		Blocks to 4-in. thick
		23.2	Foamsil	Blocks, bricks, tubular	Tank linings, evaporator bodies, tower packing, autoclave bodies	Blocks and bricks to 3 in.-thick

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
189	Polymer Corp. of Penna. Reading Penna.	24.9	Polypenco	Sheets, plates, rods, bars, tubular	Agitator blades, gaskets, pump and valve packings, gears, bearings	
		24.11.1	Polypenco	Sheets, plates, rods, bars, tubular	Tank linings, gaskets, pump and valve packings, bearing seals	Teflon
		24.15	Polypenco	Sheets, plates, rods, bars, tubular, moldings	Tank linings, gaskets, pump and valve packings, bearings, seals	Chlorinated polyether plastic
190	H. K. Porter Co., Inc. Quaker Rubber Div. Pittsburg, Calif.	25.1.2, 25.2–25.5		Sheets	Tank linings, pump valve packing, gaskets	
		25.6, 25.7		Sheets	Gaskets	
191	H. K. Porter Co. Refractories Div. Pittsburgh, Pa.	23.5		Brick, castables	High-temperature construction	Firebrick, silica brick, acid brick
192	Raybestos-Manhattan, Inc. Passaic, N. J.	21		Powders, resins	Packing and gaskets, insulations	
		24.11.1		Powders, resins	Packing and gaskets	
		25.1.1, 25.1.2, 25.2, 25.5		Sheets	Transmission, conveyor and v-belts, hose, linings and coverings	
		25.7		Powders, resins	Molded and extruded parts, roll coverings	
193	Reeves Brothers, Inc. New York, N. Y.	24.9		Rods, sheets, tubular	Belting, insulators, prototypes, gears, rollers	
		24.10	Reevon	Rods, sheets	Air filters, wet filtration-anode bags	
		24.11.1		Rods, sheets, tubular	Packaging, insulators	
		25.1.1, 25.2–25.8	Reevecote	Sheets	Tank linings, diaphragms, gasketing material	
194	Reichhold Chemicals, Inc. White Plains, N. Y.	24.1, 24.4, 24.5		Resin powder	Coatings, plastic parts	
195	Republic Steel Corp. Cleveland, Ohio	1.3.9, 1.4.1–1.4.6, 1.5.1–1.5.30 1.2.1	Enduro	Plates, bars, sheets, tubes, rod, strip	Process equipment	
196	Resistoflex Corp. Roseland, N. J.	24.6.4	Compar	Bars, tubes, sheets and hose assemblies	Process piping and hose	
		24.11.1	Fluoroflex-T	Hose assemblies, lined pipe, fittings, expansion joints		
		24.11.2	Fluoroflex-C	Rods, sheets and tubing		
197	Revere Copper and Brass Inc. New York, N. Y.	2.1, 2.3, 2.4, 2.6, 2.8, 2.9, 2.10, 2.12, 2.13, 2.18, 5.1.1–5.1.4, 5.2.1–5.2.7, 5.2.9, 5.2.10, 5.2.12, 5.2.13, 5.2.14, 5.3.1, 5.3.2, 5.4.1, 5.5.1, 5.5.2, 5.6.1		Sheets, plates, rods, bars, tubular, forgings	Heat exchanger tubings, stills, evaporators, tanks, mixers	
198	Reynolds Metals Co. Richmond, Va.	2.1–2.18		Pig, ingot, sheet, plate wire, rod and bar, extrusions, tube, pipe, granulated shot and 50.99% Al	Tubing, tanks, heat exchangers, columns, insulating jackets	
199	Robinson Clay Product Co. Akron, Ohio	23.5		Brick, castables	High-temperature equipment components, linings	Fireclay
200	Rogers Corp. Rogers, Conn.	21	Duroid	Sheets and punchings	Gaskets and packings	
		24.1		Pellets	Phenolic moldings	
		25.3, 25.7		Moldings	Rubber molded to specifications	
		26	Duroid	Sheets, rods, tubes	High-temperature insulation	Reinforced Teflon
201	Rohm & Haas Co. Philadelphia, Pa.	24.4	Paraplex	Synthetic resins	Tanks and tank lining, pipes, impellers, exhaust hoods	
		24.7	Plexiglas	Sheet, molding powder	Chlorinators pump impellers, salt water pump parts, piping	
		24.7	Implex	Molding powder	Pump impellers, pump casings, piping, valve parts, water purifier heads, textile bobbins	

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
202	Roll-Weld Pipe and Tube, Inc. Jacksonville, Fla.	1.3.9, 2.1–2.15....	.....	Pipe, tube.....	Process piping and tubing	
203	Ross-Meehan Foundries Chattanooga, Tenn.	1.1.1–1.1.4, 1.2.2, 1.4.1–1.4.6, 1.6.1–1.6.28....	.....	Castings.....	Valves, pump parts, conveyors	
204	Ruberoid Co. New York, N. Y.	21.....	.....	Sheets.....	Linings, roofs, sidewalls	Asbestos-cement board
205	Scovill Manufacturing Co. Waterbury, Conn.	5.2.1–5.2.3, 5.2.7, 5.3.1, 5.1.2, 5.1.3, 5.2.13, 5.5.1.....	.....	Tubular.....	Heat exchanger tubing	
		5.2.6, 5.2.12, 5.2.13, 5.5.2, 5.6.1.....	.....	Rod.....	Bolts, nuts, tie-rods	
		2.1, 2.4, 2.8.....	.....	Sheet, strip.....	Heat exchanger fin stock	
206	Sharon Steel Corp. Sharon, Pa.	1.2.1, 1.3.9, 1.4.1–1.4.6, 1.5.1, 1.5.2, 1.5.5, 1.5.6, 1.5.7, 1.5.10, 1.5.11, 1.5.14, 1.5.15..	.....	Stripe.....	Chemical process equipment	
207	Shell Chemical Corp. New York, N. Y.	24.5.....	.....	Resins.....	Reinforced plastics	
208	A. O. Smith Corp. Glascote Products Inc. Cleveland, Ohio	1.3.2.....	Glascote.....	Tubular.....	Piping systems	
209	Spencer Chemical Co. Kansas City, Missouri	24.10.....	Poly-Eth.....	Molding resins.....	Pipe, tubing, tank linings, impeller linings	
		24.9.....	.....	Molding resins.....	Intricate and massive molding applications	
210	Stackpole Carbon Co. St. Marys, Pa.	22.1–22.4.....	.....	Bars, tubes, sheets....	Rocket nozzle inserts, high-temperature seal rings, bearings	
211	Stainless Foundry and Engineering, Inc. Milwaukee, Wis.	1.6.1–1.6.14, 4.1, 10.1, 10.2, 10.3, 10.5, 10.6.....	.....	Sand castings.....	Pumps, valves	
212	Standard Tube Co. Detroit, Mich.	1.2.1, 1.5.5–1.5.18, 4.2.....	.....	Tubes, pipe.....	Heat exchanger tubing	
213	Stokes Molded Products Trenton, N. J.	24.6.1.....	.....	Moldings.....	Pipe fittings, pumps, valves	
214	Superior Tube Co. Morristown, Pa.	1.2.1, 1.4.3, 1.5.1, 1.5.4–1.5.7, 1.5.9, 1.5.11, 1.5.13–1.5.21, 1.5.23–1.5.28, 1.5.31, 3, 10.1–10.5, 14.1, 19...	.....	Tubing.....	Heat exchanger tubing and fluid carrying lines	
215	Synthane Corp. Oaks, Penna.	24.1, 24.3, 24.5...	.....	Sheets, rods, tubes		
16	Chas. Taylor Sons Co. Cincinnati, Ohio	23.5.....	Tasil, Tamul, Tamax.....	Bricks, shapes.....	Furnace linings, carbon reactors.....	Mullite
			Taycor.....	Bricks, shapes.....	Carbon reactors, furnace linings.....	Alumina
			Hydrocast.....	Castable.....	Furnace linings	
217	Texas-U. S. Chemical Co. Port Neches, Tex.	25.2.....	.....	Sheets.....	Linings	
218	Thermal American Fused Quarts Co. Dover, N. J.	23.2.....	Vitreosil.....	Tubes, pipes, trays, plates, fabricated special shapes	Pipe, retorts, evaporating dishes, U-bends, return bends	Opaque pipes up to 24-in. O.D. and 5-ft. long
219	Thiokol Chemical Corp. Trenton, N. J.	25.6.....	.....	Liquid, sheet.....	Gaskets, tank lining...	Polysulfide polymers
220	H. I. Thompson Fiber Glass Co. Los Angeles, Calif.	23.2.....	.....	Fibers, sheets.....	High-temperature rocket, missile components	High-temperature fibrous material; phenolic laminated silica fibers

	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
221	Timken Roller Bearing Co. Canton, Ohio	1.4.1, 1.4.4, 1.4.6.	.....	Tubes, bars.....	Heat exchanger tubing, valve bodies	
222	Titanium Metals Corp. of America New York, N. Y.	14.1, 14.2, 14.4...	Timet.....	Wire, tubular, strip, forging billet, extruded shapes	Heat exchanger tubing, tank linings, pump barrels, autoclaves, reactor vessels, filter screens, bayonet tubes, valves	
223	Tube Reducing Corp. Wallington, N. J.	1.5.2, 1.5.4–1.5.6, 1.5.14, 1.5.15, 1.5.17, 1.5.18...	.....	Tubular.....	Condenser tubing, heat exchanger tubing, piping systems, hydraulic tubing	
224	Trent Tube Co. East Troy, Wisconsin	1.5.2, 1.5.3, 1.5.5–1.5.12, 1.5.14–1.5.18, 1.5.25, 1.5.34, 10.3, 10.5, 10.6, 14.1, 19	Trentweld Contourweld.....	Pipe and tubing.....	Heat-exchanger tubing, bulk process pipe lines, high-pressure piping	Pipe and tubing from ⅛-in. O.D' to 40-in. O.D.
225	Union Carbide Corp. Union Carbide Plastics Co. New York, N. Y.	24.1, 24.4, 24.5, 24.8.....	.....	Resin powder.....	Linings, pipe, valves	
		24.6.1, 24.6.2, 24.10.....	.....	Resin powder.....	Linings, pipe, valves	
226	Union Carbide Corp. Electro Metallurgical Co. Niagara Falls, N. Y.	13, 17.....	.....	Bars, wire, strip.....	Tanks, tubing, racks...	Development or semicommercial
227	Union Carbide Corp. Haynes Stellite Co. Kokomo, Ind.	4.1.....	.....	Castings, rod.....	Knives, bushings and half bushings, wear strips, sleeves and balls	
		4.2.....	Multimet.....	Sheet, plate, billets, bar, rods, wire, tubing	High-temperature equipment	
		10.5.....	Hastelloy alloy B, C, F, X	Sheet, plate, billets, bar, rods, wire, tubing, pipe, castings	Chemical equipment, linings, valve bodies, autoclave bodies	
		10.6.....	Hastelloy alloy D....	Castings.....	Sulphuric acid concentrator tubes and dip nipples, valve and pump bodies	
228	Union Carbide Corp. National Carbon Co. New York, N. Y.	22.1.....	.....	Brick, plates, blocks, tubes, cylinders	Electrostatic precipitator tubes, tank linings, tower internals, towers, vessels, tower packing, pipe liners	
		22.2.....	.....	Plates, block, tubes, cylinders	Towers, vessels, bubble cap trays, tower internals, conductor and conveyor rolls, heat-exchanger tubing, reactor linings, piping and fittings, combustion chambers	
		22.2.....	.....	Plates, blocks, tubes, cylinders	Heat exchanger tubing, tube sheets and covers, pipe and fittings, reactor linings	Non-resin impregnator graphite stock. Designated as Code 8L. Low permeability with a low limit of 1 milli-darcy
		22.4.....	Karbate.....	Plates, blocks, tubes, cylinders	Towers, heat exchanger tubing, tube sheets and covers; pumps, valves; pipe and fittings	
		22.3.....	Karbate.....	Plates, blocks, tubes, cylinders	Towers, pump seals; valve parts, conductor and conveyor rolls; tower internals; vessel linings; pipe liners; piping	
229	Union Carbide Corp. Silicones Div. New York, N. Y.	25.7.....	.....	Sheets.....	Gaskets, linings	
230	U. S. Pipe & Foundry Co. Burlington, N. J.	1.1.1–1.1.6, 1.2.1, 1.2.2, 1.3.1–1.3.10, 1.4.1–1.4.6, 1.5.1–1.5.16, 1.6.1–1.6.28	.....	Tubing.....	Piping systems	

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	MANUFACTURER	MATERIAL	TRADE NAME	FORMS	APPLICATIONS	REMARKS
231	United States Rubber Co. New York, N. Y.	24.4, 24.5	Vibrin	Raw material	Housing, ducting (fumes)	
		24.6.1, 24.14, 24.15	Marvinol	Powder	Pipe, valve bodies, ducting (fumes)	Uscolite pipe and fittings
		25.1.1, 25.1.2, 25.2	Kralastic	Cubes	Pump impellers, valve bodies, pipe	
		25.3	Paracril	Synthetic rubber bales		
		21	Asbeston	Fabric	Pipe lagging	
232	U. S. Steel Corp. Pittsburgh, Pa.	1.2.1, 1.4.1–1.4.6, 1.5.1–1.5.33		Plates, bars, sheets, tubes, rod, strip	Process equipment	
233	U. S. Steel National Tube Div. Pittsburgh, Pa.	1.2.1, 1.4.1–1.4.6, 1.5.5, 1.5.11, 1.5.14, 1.5.18, 1.5.20, 1.5.25, 24.6.1, 24.6.2, 24.10	USS National	Pipe and tubes		
234	U. S. Stoneware Co. Akron, Ohio	23.3	Cerachlor	Tubes, bars, rods	Piping, pumps ,filters	
		23.4	Ceratherm	Tubes, bars, rods	Piping, pumps, filters	
		23.6	Alite	Tubes, special shapes	Pump seals, pump plungers	
		24.6.1	Tygon	Tubing	Molded parts, tubing	
		24.11.1		Tubing	Tubing systems	
235	Vanadium Corp. of America New York, N. Y.	17		Bars, sheets, plates, wire, tubing, strips, rods		
236	Wah Chang Corp. New York, N. Y.	8		Wire, rod, powder, ingot	High-temperature equipment	
		12		Wire, rod, powder, sheet, foil	Acid heaters, equipment lining	
		13		Wire, rod, powder, sheet, ingot, foil	Atomic reactor components, lining	
		16		Wire, rod, powder	Wear-resistant surfaces	
		19		Ingot, reactor foil	Heat exchangers, reactors, valves	
		20		Ingot, reactor foil	Atomic reactor components	Hafnium
		15		Pig	Lining	
237	Wallingford Steel Co. Wallingford, Conn.	1.5 1, 1.5.2, 1.5.5–1.5.7, 1.5.9–1.5.11, 1.5.14–1.5.18, 1.5.21, 1.5.22, 1.5.25		Welded tubing, strips	Heat exchanger tubing, condenser tubing, evaporator tubing, process piping, reactor tubing	
238	Walsh Refractories Corp. St. Louis, Mo.	23.5		Brick, castable		Firebrick, alumina mullite, sircon
239	Washington Steel Corp. Washington, Pa.	1.5.1, 1.5.2, 1.5.5, 1.5.7, 1.5.11, 1.5.14, 1.5.17, 1.5.18, 1.5.21, 1.5.25	MicroRold	Sheet and strip	Heat exchangers, evaporators, tank heads, linings, dryers, air heaters, textile and paper making machinery	
240	Wausheka Foundry Co. Wausheka, Wisc.	1.1.2, 1.4.2, 1.4.3, 1.4.6, 1.5.20, 1.5.25–1.5.34, 1.6.1–1.6.28, 2.14, 2.15, 2.17, 5.2.3–5.2.12, 5.3.1, 5.3.2, 5.4.1, 5.5.1, 5.5.2, 5.6.1, 10.1–10.3		Castings	Cast equipment	
241	Worthington Corp. Harrison, N. J.	1.6.14	Worthite	Bars, wire, castings	Pumps, pump impellers, pump casings, valves	
242	Yardley Plastics Co. Columbus, Ohio	24.8, 24.9, 24.10	Clearstream	Fittings, pipe, tubing	Piping systems, valves	
243	Youngstown Sheet and Tube Co. Youngstown, Ohio	1.4.6	Yoloy	Sheets, plates, bars, tubular	Tanks, piping, brine lines	1.50–2.00 Ni; 0.75–1.25 Cu
		1.4.6	Yoloy E	Sheets, plates, bars	Tanks	0.50–1.00 Ni; 0.25–0.50 Cu; 0.20–0.40 Cr
244	Zirconium Corp. of America Solon, Ohio	23.5		Bars, tubes, balls, sheets	High-temperature furnace linings, rocket nozzles, catalyst supports	

Inventory of Current Literature

Use this selected list of new literature for information on materials of construction with the Reader Service Card on p. 235.

	BULLETIN NO.	PROD. HIST.	PHYS. PROP.	TEMP. LIMITS	CORR. RESIST.	FABRICATION	FORMS AVAIL.	COST DATA	CASE HIST.	PAGES	REMARKS	READER SERVICE NO.
IRONS												
Bethlehem Foundry & Machine Co.	200		x	x	x		x			4		M-1
Duriron Co., Inc.	A/2a	x	x	x	x		x			8		M-2
Link-Belt Co.	1850		x	x					x	23		M-3
CARBON STEELS												
Bethlehem Steel Co.	623	x	x				x		x	4		M-4
	189	x					x			2		M-5
Crucible Steel Co.	ADV155	x	x	x	x	x				232	Stock book	M-6
Jessop Steel Co.	3M-3-58		x	x	x	x			x	60		M-7
Republic Steel Corp.	ADV-794		x				x			32		M-8
Standard Tube Co.	———	x				x	x			4		M-9
CLAD, BONDED STEELS												
Armco Stee lCorp.	PO4157	x	x	x	x	x	x		x	24	Aluminized steel	M-10
Jessop Steel Co.	2977		x	x	x	x	x		x	12		M-11
Lukens Steel Co.	817	x	x	x	x	x	x	x	x	28	Design data	M-12
Metals & Control Corp., General Plate Div.	———	x					x			12	Precious metals	M-13
National Steel Corp., Weirton Steel Co. (Div.)	572		x				x			8		M-14
ALLOY STEELS												
Alco Products, Inc.	SF-2	x	x	x	x					——		M-15
Babcock & Wilcox Co., Tubular Prod. Div.	9					x	x			46	Tubing	M-16
	153		x							4	Stress rupture	M-17
Bethlehem Steel Co.	450	x			x		x			8	Al coating process	M-18
	649		x			x	x			4		M-19
Crucible Steel Co.	ADV195		x	x	x	x				8	Maxeloy	M-20
Lukens Steel Co.	781	x	x	x	x	x	x	x	x	24		M-21
Republic Steel Corp.	ADV-540		x	x	x					56		M-22
U. S. Steel, National Tube Div.	26		x	x	x	x	x			——		M-23
WROUGHT STAINLESS STEELS												
Allegheny Ludlum Steel Corp.	SS-31		x	x	x	x	x			120	Handbook	M-24
	SS-30		x	x	x	x	x			394	Fabrication book	M-25
	SS-33		x	x	x	x	x			20	Wire	M-26
	SS-38		x	x	x	x	x			32	Sheet & strip	M-27
	SS-11		x	x	x	x	x		x	36		M-28
Armco Steel Corp.	PO5156								x	8	Tank applications	M-29
	PO4757	x	x	x		x	x		x	28		M-30
	PO1257	x	x	x	x		x			48		M-31
	PO1258		x	x	x	x	x		x	8	Extra-low carbon	M-32
Babcock & Wilcox Co., Tubular Prod. Div.	413	x				x	x	x		6	Also Ti	M-33
	6		x	x	x	x			x	142	Also alloy steels	M-34
	1	x	x	x	x	x	x			106	Tubing	M-35
	365					x	x			8		M-36
	410		x			x				8		M-37
	189		x			x				2		M-38
Carpenter Steel Co.	———		x	x	x	x	x			142	Working data	M-39
	———		x	x	x	x	x			20	Stainless No. 20	M-40
	———		x		x	x	x			12		M-41
Chase Brass & Copper Co.	———						x	x		8	Price book	M-42
Crucible Steel Co.	ADV153		x	x	x	x				162	Fabrication	M-43
Eastern Stainless Steel Corp.	SP-100		x	x	x					8		M-44
	SW-100		x							2		M-45
General Alloys Co.	561R					x	x		x	4		M-46
Jessop Steel Co.	3913		x	x	x	x	x			——		M-47
Jones & Laughlin Steel Corp., Stainless & Strip Div.	WM458-10		x	x	x	x	x			——		M-48
	CD458-8				x					——	Extensive tables	M-49
	DS458-8	x	x	x	x	x				——	Data sheets	M-50
Ohio Steel Foundry Co.	FC-658		x							1		M-51
	FC-153-4		x							4		M-52
Sharon Steel Corp.	———		x	x	x	x	x			32		M-53
Standard Tube Co.	———					x	x			8	Also carbon steel pipe	M-54
Superior Tube Co.	21	x	x	x	x	x	x			56	Tubing	M-55
	———	x	x	x			x			8	Tubing	M-56
Timken Roller Bearing Co.	———	x	x	x		x	x		x	52	Tubing handbook	M-57
U. S. Steel, National Tube Div.	3		x	x	x	x	x			——		M-58
Washington Steel Corp.	7-57		x		x	x	x			24		M-59
Electro Metallurgical Co., Union Carbide Corp.	F-20,096	x	x	x	x	x	x	x	x	6		M-60
	F-20,074		x	x	x					——	Selector chart	M-61

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CAST HIGH ALLOYS												
Babcock & Wilcox Co., Alloy Div.	S-17		x	x						38		M-62
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Cooper Alloy Corp.	———		x		x					4	Also chem. analysis	M-64
Duriron Co., Inc.	A/2a	x	x	x	x		x			8		M-65
	C/1	x	x							4		M-66
Electric Steel Foundry Co.	175-B		x	x	x					100		M-67
Empire Steel Castings, Inc.	556C		x		x					4		M-68
	156H		x	x						2	High-temp. prop.	M-69
	ISO40		x		x					2	P.H. Stainless	M-70
General Alloys Co.	571		x							4		M-71
Jessop Steel Co.	4166		x	x		x	x		x	12		M-72
Mueller Brass Co.	FM-3000	x	x	x		x	x			21		M-73
	FM-3018	x	x			x	x			33	Design data	M-74
Ross-Meehan Foundries	RM-20		x	x	x					4		M-75
Stainless Foundry & Eng., Inc.	ENR		x	x	x					4		M-76
ALUMINUM AND ALLOYS												
Aluminum Co. of America	AD609	x			x		x			8	Use of Al in process industries	M-77
American Smelting & Refining Co.	101		x	x	x	x				62		M-78
Duraloy Co.	3354-G		x	x	x		x			———		M-79
Frontier Bronze Corp.	40E	x	x	x	x				x	24		M-80
Harvey Aluminum Co.	———		x				x			12	Mill products	M-81
Kaiser Aluminum & Chem. Sales, Inc.	GI-3		x	x	x	x	x			24		M-82
Mueller Brass Co.	H-58563	x		x		x	x			7	Al-bronze alloys	M-83
BERYLLIUM, COBALT AND ALLOYS												
Beryllium Corp.	———	x	x	x			x			8	Beryllium oxide	M-84
	———	x	x	x	x	x	x	x		8	Beryllium metal	M-85
	———	x				x		x	x	16	Industrial hygiene of Be	M-86
	———	x				x	x	x	x	20	General on Be	M-87
Superior Tube Co.	7	x	x	x	x	x	x			———	Beryllium-copper tubing	M-88
Haynes Stellite Co., Union Carbide Corp.	30,041		x	x	x	x	x			28	Haynes No. 25 cobalt alloy	M-89
COPPER AND ALLOYS												
American Brake Shoe Co., National Bearing Div.	10M58		x				x			6	Copper & bronze	M-90
	J-4515	x	x				x			23	Copper, bronze & babbitt	M-91
American Smelting & Refining Co.	112		x	x	x	x				66		M-92
Ampco Metal, Inc.	PI-5a	x	x	x	x	x	x			12		M-93
	WP-2a	x	x	x	x	x	x			18	Wrought products	M-94
Bridgeport Brass Co.	———	x	x	x	x	x	x		x	230	Brass & copper alloys	M-95
	———	x	x	x	x	x	x	x	x	162	Condenser tubes	M-96
	———	x	x	x	x	x	x	x	x	24	Duplex tubes	M-97
	———	x	x		x	x	x	x	x	12	Cored forgings	M-98
Chase Brass & Copper Co.	———		x	x	x	x	x			9	Silnic bronze	M-99
	D-1		x	x	x	x	x			———		M-100
Frontier Bronze Co.	Facts		x			x	x			4		M-101
Mueller Brass Co.	H-58570	x				x	x			6	Tubing	M-102
	FM-3014		x							35	Specifications	M-103
	FM-3010	x	x	x		x	x			24		M-104
Revere Copper & Brass Inc.	13	x	x		x	x	x	x	x	38	Extrusions	M-105
INDIUM, LEAD, MAGNESIUM, MOLYBDENUM AND ALLOYS												
American Smelting & Refining Co.	181	x	x				x			4	Indium	M-106
	162	x	x	x	x	x	x			46	Extensive tables on lead	M-107
Fansteel Metallurgical Corp.	———	x	x	x	x	x	x		x	24	Molybdenum	M-108
Dow Chemical Co.	141-96	x	x	x	x	x				113	Magnesium	M-109
	141-91	x	x	x	x	x				239	Magnesium	M-110
	141-186		x	x	x	x				55	Magnesium	M-111
	141-185		x			x				17	Magnesium	M-112
NICKEL AND ALLOYS												
Duriron Co., Inc.	A/3	x	x	x	x		x			4		M-113
Stainless Foundry & Engineering, Inc.	YNY				x					2	Applications	M-114
Haynes Stellite Co., Union Carbide Corp.	30,061		x	x	x	x	x			104	Hastelloy B, C, D & F	M-115
	30,037		x	x		x	x			28	Hastelloy X	M-116
	30,036		x	x	x	x	x			24	Multimet	M-117
	30,052		x	x		x	x			12	Hastelloy R-235	M-118
NOBLE METALS AND ALLOYS												
Handy & Harman	A-1		x	x		x	x			4		M-119
	A-2		x	x		x	x			6		M-120
	A-3		x	x		x	x			6		M-121
Kennametal, Inc.	L-501		x	x	x	x	x		x	2		M-122
TANTALUM, NIOBIUM AND ALLOYS												
Fansteel Metallurgical Corp.	———	x	x	x	x	x	x			20	Tantalum	M-123
Kennametal, Inc.	———		x			x	x			2	Tantalum	M-124
	———		x			x	x			2	Niobium	M-125

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TITANIUM AND ALLOYS												
Crucible Steel Co.	———		x		x					18	C135 AMo	M-126
	———		x		x					13	B120 VCA	M-127
	———		x		x					6	C115 AMOV	M-128
	———		x		x					6	C105 VA	M-129
E. I. du Pont de Nemours & Co.	A-6954	x	x	x	x	x	x		x	12		M-130
Kennametal, Inc.	3-444A		x	x	x	x	x		x	12		M-131
Superior Tube Co.	44	x	x			x	x			6	Tubing	M-132
Titanium Metals Corp. of America	RG	x	x				x			32		M-133
	DS-COR				x	x	x	x	x	12		M-134
	EB-6					x				32		M-135
	PGCC		x		x				x	12		M-136
Electro Metallurgical Co., Union Carbide Corp.	F-20,064		x	x	x	x				14		M-137
	F-20,076					x		x	x	10	Directory of fabricators	M-138
	F-20,077		x	x	x	x	x			20		M-139
TUNGSTON, ZINC AND ALLOYS												
Fansteel Metallurgical Corp.	———	x	x	x	x	x	x		x	24	Tungsten	M-140
Kennametal Inc.	3-111A	x	x		x	x	x		x	24	Tungsten	M-141
New Jersey Zinc Co.	———		x	x	x					56	Zamak alloys (zinc)	M-142
	———		x	x	x	x		x	x	24	Pressed brass	M-143
ZIRCONIUM AND ALLOYS												
Allegheny Ludlum Steel Corp.	TH-5		x	x	x					6		M-144
Carborundum Metals Co.	MZF	x	x	x	x		x			8	Published periodically	M-145
	A-1297	x	x	x	x	x	x			68		M-146
	AMT				x	x	x		x	12	Published periodically	M-147
Columbia-National Corp.	RG		x	x		x	x			4		M-148
	CG		x	x	x	x	x			8		M-149
Firth Sterling Inc.	ZTB-1	x	x		x	x	x			4		M-150
Superior Tube Co.	112	x	x		x	x	x			4	Tubing	M-151
ASBESTOS MATERIALS												
Keasbey & Mattison Co.	AP-15									8	Pipe	M-152
Atlas Asbestos Co.	TEX		x		x		x			2	Also glass textiles	M-153
CARBON AND GRAPHITE												
Graphite Specialties Corp.	GS-101-1		x	x	x	x	x			4		M-154
Kearney Industries, Delanium Graphite Div.	456			x			x			4	Heat exchangers	M-155
	———				x					1	Corrosion	M-156
	———			x			x			1	Heat exchangers	M-157
	———			x			x			1	Rupture disks	M-158
Stackpole Carbon Co.	40B	x	x	x	x	x	x			53		M-159
National Carbon Co., Union Carbide Corp.	S-5050				x					4	Tables of corrosion resistance	M-160
GLASS												
Atlas Asbestos Co.	TEX	x	x	x	x		x			2	Glass textiles	M-161
Corning Glass Works	PE-30	x	x	x	x	x			x	8		M-162
	PE-3	x	x	x	x	x	x		x	44		M-163
	PE-4		x	x	x	x	x			4		M-164
Libbey-Owens-Ford Glass Co.	SPD-59		x	x						4		M-165
	VX-1		x	x		x	x			4		M-166
Libbey-Owens-Ford Glass Fibers Co.	WMF		x	x		x	x			4	Glass fibers	M-167
Pittsburgh Corning Corp.	FB-101	x	x	x	x	x			x	24	Foamglas	M-168
	FL-101	x	x	x		x	x			20		M-169
	FB-103		x		x					4		M-170
	FB-104		x						x	12		M-171
	F1-104 to F1-104F			x						8		M-172
FUSED SILICA												
Filtros Inc.	10	x	x	x	x		x			11		M-173
Pittsburgh Corning Corp.	FS-1		x	x	x	x	x			4	Foamsil	M-174
Thermal American Fused Quartz Co.	7/57		x	x	x		x	x		1		M-175
	22		x	x	x		x	x		8		M-176
H. I. Thompson Fiber Glass Co.	PB1-2	x	x	x	x		x			——	Fibers	M-177
CHEMICAL PORCELAIN AND STONEWARE												
Coors Porcelain Co.	858		x	x	x					4		M-178
	1956	x	x	x	x		x	x		48		M-179
Filtros, Inc.	F-35		x	x	x		x			4		M-180
General Ceramics Corp.	CHE-R6		x	x	x					15	Also graphite and alumina	M-181
Maurice A. Knight Co.	11				x		x			12		M-182
Lapp Insulator Co., Inc.	438	x	x	x	x	x	x			24		M-183
Patterson Foundry & Machine Co.	B-5612-2	x	x				x			8		M-184
Maurice A. Knight Co.	11				x		x			12		M-185
	12	x			x	x	x			12	Dimensional data	M-186

Materials of Construction

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REFRACTORIES, BRICK, STRUCTURAL CLAY												
Babcock & Wilcox Co., Refractories Div.	R-35-A	x	x	x	x		x			24		M-187
	R-49		x	x			x			2		M-188
	R-47	x	x	x	x		x			4		M-189
	R-41-A		x	x						4		M-190
	R-34-B	x	x	x	x		x			28		M-191
	R-2-H	x	x	x			x			16		M-192
Carborundum Co., Refractories Div.	5120		x	x	x		x			20		M-193
	5056		x						x	24		M-194
	5057		x	x	x		x			4		M-195
	5117		x	x						32	Installation	M-196
	5119			x			x			8		M-197
	5118		x				x		x	56		M-198
Ironton Fire Brick Co.	108		x				x		x	4	70% Al_2O_3 brick	M-199
	104		x	x						4	Installation	M-200
	File D		x				x		x	4	Fireclay brick	M-201
	#4						x			6	Brick sizes	M-202
Logan Clay Products Co.	LCP857-97				x	x			x	4	Clay pipe	M-203
McDanel Refractory Porcelain Co.	B1-56						x			16	Mill linings	M-204
	P258R	x	x	x			x			—		M-205
Norton Co.	862		x	x	x	x	x			24	Refractory brick	M-206
	1741		x	x	x	x	x			24	Refractory grain	M-207
	1992		x	x	x	x	x			4	Castable refractories	M-208
	1795	x	x	x	x	x	x			12	Metal melting	M-209
	140	x	x		x	x	x			16	Porous media	M-210
	863	x	x	x		x	x			16	Refractory cements	M-211
	880	x	x	x		x	x	x		8	Cores, tubes, muffles	M-212
	2152	x	x	x	x		x			16	Borides, carbides nitrides, oxides	M-213
North American Refractories Co.	———		x	x						2	Block insulation	M-214
	———		x	x						2	Refractory cement	M-215
	———		x	x						2	Refractory cement	M-216
	———		x	x		x				4	Plastics & castables	M-217
H. K. Porter Co., Inc., Refractories Div.	———		x	x	x	x	x		x	154	Complete catalog	M-218
Robinson Clay Product Co.	R-257-66		x	x			x			20	Firebrick & castables	M-219
Chas. Taylor Sons Co.	202-R		x	x	x		x		x	15	Zircon	M-220
	323		x	x	x		x			2	Mullite	M-221
Haynes Stellite Co., Union Carbide Corp.	30,115		x	x	x	x	x		x	12	Metal-ceramics	M-222
	30,114		x	x	x	x	x		x	8	Silicon nitride	M-223
Walsh Refractories Corp.	———		x	x					x	2	Super-duty firebrick	M-224
	———		x	x					x	2	High-duty firebrick	M-225
	HA-1-58		x	x					x	2	High-alumina firebrick	M-226
	———		x	x					x	1	Plastic firebrick	M-227
Zirconium Corp. of America	BR-2		x	x		x	x			4	Zirconia	M-228
PHENOLICS												
Dow Chemical Co.	122-87	x							x	16		M-229
Haveg Industries, Inc.	F-7		x	x	x	x	x			64		M-230
Hooker Chemical Corp., Durez Plastics Div.	400	x	x	x	x	x	x			8	Also polyesters	M-231
Synthane Corp.	———	x	x	x	x	x	x			28	Laminated plastics, also melamines and epoxies	M-232
POLYESTERS, POLYETHERS												
Celanese Corp. of American, Plastics Div.	M1		x	x	x		x			4	General data	M-233
	M2B		x	x	x		x			6		M-234
	M2D		x	x	x		x			4		M-235
	M2E		x	x	x		x			4		M-236
	M25		x	x	x		x			8	Thixotropic resins	M-237
	M2	x				x	x			6	Vacuum injection	M-238
	M6	x				x	x			6	Casting	M-239
	M45	x				x	x			6	Pre-mix molding	M-240
Haveg Industries, Inc.	P-10		x	x	x	x	x			32		M-241
Hercules Powder Co.	500-291A	x	x	x		x	x			6	Chlorinated polyether	M-242
	500-306				x					—		M-243
Hooker Chemical Corp., Durez Plastics Div.	400	x	x	x	x	x	x			8	Polyesters and phenolics	M-244
EPOXIES												
Carl N. Beetle Plastics Corp.	———	x		x	x	x			x	11	Also polyesters	M-245
Duriron Co., Inc.	A/4b	x	x	x	x		x			6		M-246
Houghton Laboratories Inc.	602	x	x	x	x	x	x			4		M-247
	6000-807		x	x	x	x	x			1		M-248
Minnesota Mining & Mfg. Co.	2A		x	x	x					4		M-249
	7-8M(185)JR	x	x	x	x	x	x	x	x	28		M-250

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VINYLS												
Alpha Plastics, Inc.	A-557		x	x	x	x	x			12		M-251
Atlas Mineral Products Co.	CC-3		x	x	x	x				16	Extensive tables of corrosion resistance	M-252
	4-2		x	x	x					4		M-253
	9-2	x	x	x	x	x				4		M-254
Celanese Corp. of America, Plastics Div.	NP20		x	x	x		x			8	Emulsions	M-255
Colonial Plastics Mfg. Co.	———		x	x	x	x	x			24		M-256
General Tire & Rubber Co., Chemical Div.	———	x	x	x		x	x			52	Vygen	M-257
	VC6812-2		x	x						3		M-258
B. F. Goodrich Chemical Co.	PM-1		x	x	x	x	x			12		M-259
	———		x	x	x	x	x			12	Rigid vinyl	M-260
	Hycar		x	x	x	x	x			24		M-261
B. F. Goodrich Ind. Prdt. Co.	10080-A	x	x	x	x	x	x	x	x	20	PVC sheet	M-262
	10085		x	x	x					2	PVC sheet	M-263
	10050		x	x	x		x			8	PVC pipe	M-264
	10051-B	x	x	x	x	x	x	x	x	24	PVC pipe	M-265
	KR-101		x	x		x				6	PVC pipe	M-266
Goodyear Tire & Rubber Co.	58-2		x							2		M-267
	57-74		x							2		M-268
	57-105		x							2		M-269
Grinnell Co.	———		x	x	x	x	x		x	16	PVC	M-270
Industrial Plastic Fabricators	———	x	x	x	x	x	x	x	x	20	Also polyesters, epoxies & polyethylene	M-271
Jones & Laughlin Steel Corp.	AD-234		x	x	x	x	x			4	Steel-jacketed polyvinyl tubing	M-272
Kaykor Industries, Inc.	LC-58	x	x	x			x		x	12	Corrosion resistance tables	M-273
	4PF	x				x	x		x	4		M-274
	8RV	x	x	x	x	x	x	x	x	8	Rigid vinyl	M-275
Kraloy Plastic Pipe Co., Inc.	———	x	x	x			x			8	PVC pipe	M-276
Luzerne Rubber Co.	PF1200		x	x	x	x	x			8	PVC pipe, fittings & valves	M-277
Mannesmann Easton Plastic Pdts., Co., Inc.	4148		x	x	x		x			6	PVC pipe	M-278
	4155					x	x			6	PVC pipe	M-279
Stokes Molded Products	———		x		x					6	PVC	M-280
U. S. Steel, National Tube Div.	24		x	x	x		x		x	———		M-281
FURANES AND POLYPROPYLENE												
Maurice A. Knight Co.	1		x	x	x		x			4	Furanes	M-282
	6			x	x	x	x			4	Furanes	M-283
Hercules Powder Co.	500-302		x	x	x	x	x			10	Polypropylene	M-284
ACRYLICS AND NYLON												
Rohm & Haas Co.	PL-276a	———	x				x			16	Acrylics	M-285
Polymer Corp.	BR-2	x	x	x	x	x	x		x	16	Nylon	M-286
Spencer Chemical Co.	———		x							———	Nylon	M-287
E. I. du Pont de Nemours & Co.	A-7345		x	x	x	x			x	19	Acrylic, nylon, fluorocarbon and polyethylene resins	M-288
FLUOROCARBONS												
Chicago Gasket Co.	C-2, 1-A, 2A, 3		x	x						4		M-289
Fluoro Plastics Inc., Div. Flexrock Co.	———	x	x	x	x		x			18		M-290
Haveg Industries, Inc.	T-50		x	x	x		x			4		M-291
Polymer Corp.	BR-4	x	x	x	x	x	x		x	8		M-292
Resistoflex Corp.	H-1		x	x	x		x			12		M-293
	TS-1A		x	x	x		x			4		M-294
	B-1A		x	x	x		x			4		M-295
	PLA-1		x	x	x		x			4		M-296
SILICONES												
Connecticut Hard Rubber Co.	———		x	x	x	x	x			45	Silicone rubber	M-297
General Electric Co., Silicone Pdts. Dept.	CD8-129		x	x	x	x	x			8	General	M-298
	RTV-60		x	x			x			6	RTV compounds	M-299
CELLULOSICS												
Cellanese Corp. of America, Plastics Div.	A2A	x	x	x	x	x	x			8	Cellulose acetate	M-300
	A2B	x	x	x	x	x	x			8	Cellulose proprionate	M-301
	F1A	x	x	x	x	x	x			6		M-302
	B13	x	x	x	x	x	x			12	Thermoforming	M-303
POLYSTYRENES												
Dow Chemical Co.	171-39C		x						x	9		M-304
	171-83		x		x	x				8	Styrene-acrylon-nitrate	M-305
	157-12-57	x	x						x	8		M-306
	157-3-57	x	x						x	24		M-307
	171-48B	x	x						x	18		M-308
	157-43		x						x	4	Scorbord	M-309
Yardley Plastics Co.	230									4	Drain & pipe	M-310
	151		x	x	x	x				8	Pipe	M-311
	259							x		4	Pipe & fittings	M-312

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POLYETHYLENES												
Allied Chemical Corp., Semet-Solvay Petrochemical Div.	———		x	x	x		x			24		M-313
	———		x	x	x		x			16		M-314
	———		x	x	x		x			13		M-315
Celanese Corp. of America, Plastics Div.	———	x	x	x	x	x	x			54	Linear	M-316
E. I. du Pont de Nemours & Co.	A-4813		x	x	x	x			x	20	Also nylon, acrylics & fluorocarbons	M-317
Dow Chemical Co.	171-82		x		x	x				8		M-318
Dow Corning Corp.	1-114		x	x			x		x	15	General catalog	M-319
	10-105		x	x			x		x	12	Dielectrics	M-320
Hercules Powder Co.	500-273A	x	x	x	x	x	x			44		M-321
Mueller Brass Co.	5-1021	x	x				x			11	Pipe	M-322
Spencer Chemical Co.	———		x							———	High density	M-323
	———		x							———	High density	M-324
U. S. Steel, National Tube Div.	29		x	x	x	x	x			———		M-325
Yardley Plastics Co.	50		x	x	x	x				4	Pipe	M-326
POLYURETHANES												
General Tire & Rubber Co., Chemical Div.	GT-2		x	x	x	x	x			12	Compounding	M-327
Thiokol Chemical Corp.	———		x			x			x	12	Rigithane 112	M-328
	———		x	x		x			x	5	Solithane 113	M-329
RUBBER-LIKE MATERIALS												
Automotive Rubber Co., Inc.	43055			x	x					6	Chem. resis. tables	M-330
	7155A		x							4	Samples	M-331
Dow Chemical Co.	171-85	x	x						x	8	Saraloy 400	M-332
Dow Corning Corp.	9-106		x	x		x	x		x	4	Mechanical app.	M-333
	9-105		x	x		x	x		x	4	Dielectric app.	M-334
E. I. du Pont de Nemours & Co.	A-7328	x	x	x	x				x	16		M-335
Electro Chemical Eng. & Mfg. Co.	B-P-1		x	x						1	Tank linings	M-336
Gates Rubber Co.	MRG-460		x		x	x	x			24	Also covers vinyls	M-337
	MRG-461		x	x	x	x	x			52	Also covers vinyls	M-338
B. F. Goodrich Chemical Co.	———		x	x	x	x	x			24	Hycor rubber	M-339
Goodyear Tire and Rubber Co.	58-38		x							2		M-340
	57-322		x							2		M-341
Maurice A. Knight Co.	2		x	x	x		x		x	8		M-342
La Favorite Rubber Co.	———		x	x								
Linatex Corp. of America	456	x	x	x	x	x	x		x	12	Tables available	M-343
Luserne Rubber Co.	PF1300		x	x	x	x	x			8	Hard rubber pipe, fittings & valves	M-344
Thiokol Chemical Corp.	102		x							12		M-345
	105				x					8		M-346
	108				x					8		M-347
U. S. Rubber, Naugatuck Chemical Div.	No. 1		x		x	x				32	Nitrile rubbers	M-348
	No. 2		x		x	x				16	Nitrile rubbers	M-349

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Flare Stacks—How Tall?

Should the flame fail, the stack must be high enough to prevent unsafe gas concentrations. But how high is high enough?

F. T. BODURTHA, Jr.
E. I. du Pont de Nemours & Co., Inc.

FLARES have been widely used in the petroleum industry for burning combustible waste gases and their use is now increasing in the chemical process industries. Complete design of flares involves a number of important considerations such as height, tip configuration, pilot burners, ignition systems and smoke reduction. This article is confined to the selection of flare stack height.

Ground Flares May Be Hazard

Ground flares sometimes are attractive alternates for elevated flares from a cost point of view. But, if the flare is extinguished during poor atmospheric dispersion conditions, dangerous concentrations of contaminants may result. Ground flares should be located away from operating and populated areas, preferably downwind from those areas on the basis of prevailing wind direction.

Frequently, use of an elevated flare is a necessity. Even with an elevated flare, a potential hazard of operation is the occurrence of toxic gases at breathing levels should a flame failure occur.

At Poza Rica, Mexico, 22 people died in 1950 from exposure to unburned H_2S from a 90-ft. flare.[1]

Prevention of flame failure cannot be guaranteed. Therefore, a flare stack should be high enough to prevent explosive or toxic concentrations of unburned gases from occurring at the ground or other operating levels in the event of flame failure. In some cases other considerations, such as potential damage to nearby structures, may dictate a higher stack than is necessary from consideration of potential pollution.

Odor thresholds of gases are usually several-fold less than the lower explosive limits or toxic concentrations. A flare stack, designed for a height to protect against dangerous concentrations in the event of flame failure, can usually be lower than a conventional stack would have to be to prevent odor. With a flare stack, odor detection would be probable during the infrequent and short periods of flame failure. Such detection would be a signal of flame failure, but should not be depended upon as the only signal.

In the use and design of flare stacks, you should consider the possible creation of toxic or odor problems from the products of combustion. The heat from the flame, however, will cause the plume to rise to a considerable height. Thus, concentrations of combustion products at the ground are greatly reduced.

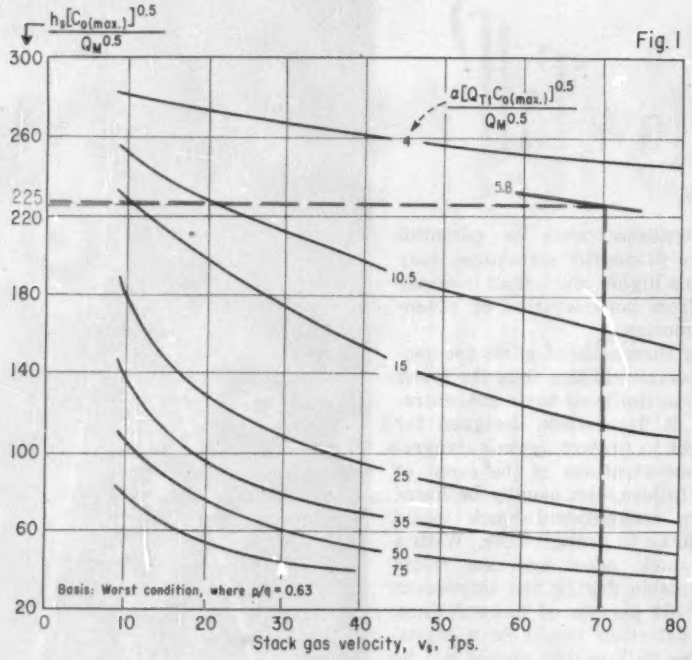
Atmospheric Dispersion

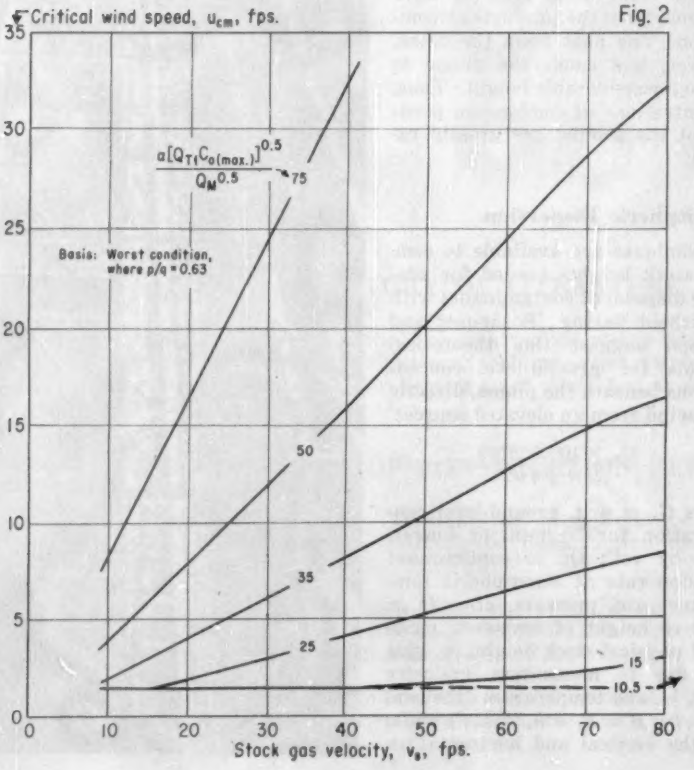
Techniques are available to compute stack heights needed for adequate disposal of contaminants with or without flaring. Bosanquet and Pearson suggest this theoretical formula for ground-level concentrations beneath the plume, directly downwind from an elevated source:[2]

$$C_o = \frac{(Q_m \times 10^6)\ (e^{-H/pz})}{(2\pi)^{0.5} p\ q\ u\ x^2} \qquad (1)$$

where C_o = avg. ground-level concentration for 30 min. or longer, ppm. by vol.; Q_m = contaminant emission rate at atmospheric temperature and pressure, cfs.; H = effective height of emission, made up of physical stack height, h_s, plus rise due to momentum (velocity rise), h_v, and temperature (thermal rise), h_t; $H = h_s + h_v + h_t$; p and q are the vertical and horizontal at-

Charts Offer a Shortcut Route to Safe Design





mospheric dispersion coefficients, respectively, dimensionless; x = downwind distance from emission source, ft.; and u = mean horizontal wind speed, ft./sec.

Gosline, Falk and Helmers have given a comprehensive discussion of the application of Eq. (1).[3] The equation gives the average concentration which occurs over a period of 30 min. or longer downwind of a source. Peak 1-min. concentrations will be about ten times C_o.[4] For a few seconds, the concentration may reach as high as 50 C_o.[5]

There is some distance, x_m, at which C_o in Eq. (1) is a maximum. By maximizing Eq. (1) with respect to x:

$$x_m = H/2p \qquad (2)$$

and

$$C_o(\text{max.}) = \frac{2.15(Q_m \times 10^6)\ (p/q)}{uH^2} \qquad (3)$$

The values of p and q that are commonly used with the Bosanquet-Pearson equation are given in the table on the next page.

Low turbulence is associated with a stable atmosphere in which air temperature increases with height (temperature inversion). Moderate turbulence is usually associated with an unstable atmosphere in which the air temperature decreases relatively rapidly with height.

We can see from the table and from Eq. (1) that maximum concentrations of contaminants occur with average or moderate turbulence, since for these conditions (p/q) is larger than at low turbulence. Note, however, that the maximum concentration occurs farthest from the stack for low turbulence. Also, concentrations near the maximum will cover a much larger distance range for low turbulence than for other atmospheric conditions.

Odor in the community—if it occurs at all—in the event of flame failure is most likely, therefore, during periods of low turbulence.

What's a Safe Height?

For design purposes, the highest value of (p/q) occurring with average or moderate turbulence is about 0.63. Therefore, the minimum required flare stack height for any given maximum tolerable C_o from the safety standpoint is:

$$h_s = \frac{(1.35\,Q_m \times 10^6)^{0.5}}{[u\,C_o\ (\text{max.})]^{0.5}} - h_o - h_i \qquad (4)$$

To calculate the maximum rise of the unburned plume due to velocity of the flare gases, we can use the following equation in which we assume that $a = 2$:[6]

$$h_v\ (\text{max.}) = \frac{2.38\ a_a^{*}(Q_{T1}^{*}v_s)^{0.5}}{[1 + (0.43u/v_s)]u} \qquad (5)$$

where a = velocity and thermal rise factors, dimensionless; $a = 1$ for $\frac{1}{2}\ h_v$ (max.) or for $\frac{1}{2}\ h_t$ (max.); $a = 1.5$ for 0.75 h_v (max.) or for 0.75 h_t (max.); T_1 = temperature at which stack gas and atmospheric densities are equal, deg. K.; Q_{T1} = total gas emission rate at temperature T_1; and v_s = stack gas exit speed, ft./sec.

To calculate T_1, use this formula for gases that are at atmospheric pressure:

$$T_1 = \frac{\text{Mol. wt. of stack gas}}{29} \times T$$

where T is absolute ambient temperature, deg. K.

Where $a = 2$, the maximum rise of the unburned plume due to thermal rise is calculated from:[6]

$$h_t\ (\text{max.}) = \frac{3.18\ g\ a\ Q_{T1}\ \Delta\ Z}{u^3\ T_1} \qquad (6)$$

where g is acceleration due to gravity = 32.2 ft./sec.^{2}; $\Delta = T_s - T_1$, deg. K.; T_s = stack gas temperature, deg. K.; Z is a parameter for calculation of thermal rise, dimensionless, and consists of other parameters identified and discussed in Ref. 6 and in Ref. 3.

At x_m the maximum ground-level concentration will be attained. Eqs. (5) and (6) have not been tested for all ranges of stack gas and atmospheric parameters. Therefore, it's desirable to express the velocity and thermal rises as a fixed percentage, usually 50%, of the maximum rises to provide a margin of safety.

Eq. (4) can be solved for h_s at several wind speeds. Because h_v and h_t vary with u, there will be some critical wind speed, u_{cm}, at which h_s is a maximum. This is the required flare stack height.

Shortcut Method

For the case where the waste gases are at or near atmospheric density ($\Delta = 0$), this writer has developed a shortcut technique to calculate h_s.[7] When thermal rise is insignificant, you can use Fig. 1 to calculate h_s for v_s values between 10 and 80. This speed range will suffice for some flare stack problems.

Bosanquet-Pearson Atmospheric Dispersion Coefficients

	p	q	p/q	Distance To Maximum Concentration
Low turbulence	0.02	0.04	0.50	25H
Average turbulence	0.05	0.08	0.63	10H
Moderate turbulence	0.10	0.16	0.63	5H

Critical wind speeds are shown in Fig. 2. For $v_s > 80$, it can be shown that:[7]

$$u_{cm} = \frac{16.7\ a^2\ Q_{T1}\ C_e\ v_s \times 10^{-5}}{Q_m} \qquad (7)$$

However, note that critical wind speeds less than 1.5 ft./sec., or 1 mph., resulting from the equations and graphs above are assumed to be 1.5 ft./sec.

When v_s is more than 80, u_{cm} from Eq. (7) can be substituted into Eq. (5) to solve for h_v. Then h_v and u_{cm} can be substituted into Eq. (4) to solve for h_s. Examples of this method are given below.

About Reliability

Several investigators have performed field tests of Eq. (1). (See Refs. 4, 5, 8 and 9.) These tests confirm that the concentrations predicted by the equation for 30 min. or longer agree within about twofold of the actual.

This accuracy is sufficient to calculate stack heights in view of the:

- Uncertainty of the physiological data.
- Probable inaccuracies in gas flow design data for new installations.
- Uncertainties in h_v and h_t.

There is some recent evidence that Eq. (1) may underestimate concentrations in the axis of the plume for a stable atmosphere.[10] Stable atmospheric conditions may result in lateral spread (fanning) of the plume downwind of the stack at the height of emission. The location where the resulting high concentrations in the plume are diffused down to the ground over flat terrain is not known quantitatively for the stable atmosphere. There may be situations for this case where there is insignificant diffusion of fumes to ground level over flat terrain.

On the basis of today's knowledge of atmospheric turbulence, I consider it acceptable practice to use the technique described here with a fixed percentage, usually 50%, of the maximum thermal and velocity rises.

Down in the Valley

However, this technique should not be used for plants in valleys. If flame failure occurs in a valley during stable atmospheric conditions, high concentrations of contaminants may occur due to prevention of lateral and, also, upward movement of contaminants. Also, fanning of the plume may cause very high concentrations of pollutants, if the plume strikes a nearby hillside.

If you have a potential air pollution problem, you probably should consult with a meteorologist to assist in a study of atmospheric dispersion.

Watch Stack Gas Speed

It's evident from Eq. (4) that relatively high flare stack gas speeds allow use of lower physical stack heights. To take advantage of this velocity rise, there should not be any obstructions at the tip which prevent upward ejection of the waste gases.

Besides reducing the required physical stack height, high flare stack gas speeds have these other advantages:

- Promotion of complete combustion. High speeds provide greater air entrainment and mixture (at the stack tip) which promote complete combustion and result in shorter flame lengths once turbulent flow is obtained.
- Projection of the flame vertically. High exit gas speeds tend to project the flame vertically, thus reducing flame damage to the stack tip.
- Prevention of flashback. If combustible mixtures can occur in the flare stack, high stack gas speeds are an aid in preventing dangerous flashback.

There are limitations in attaining high gas speeds in the stack. Excessively high values are undesirable, particularly in regard to extinction of the flame by blowoff. A discharge speed of 300-400 ft./sec., based on pressure drop considerations across the tip, is the optimum design figure of a patented flare tip manufactured by the John Zink Co.

Many conventional (open-pipe) flare stacks are designed for a peak speed of 150 ft./sec.

To Sum Up

One of the main considerations in the design of flares is the elimination of air pollution in the event of flame failure. Prevention of flame failure cannot be guaranteed.

This article presents a design technique which will prevent dangerous concentrations of contaminants over level terrain if flame failure occurs. This technique uses a field-tested atmospheric dispersion formula. However, we recommend that a meteorologist be consulted on stack solutions to air pollution problems.

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Sample Problems

Problem 1 (*Moderate Stack Gas Exit Speeds*)—1,200 cfm. of a nitrogen-waste gas, containing 75% of a combustible and potentially toxic waste gas, are to be burned in a flare stack. The gas mixture has a molecular weight of 29 and is at ambient air temperature ($\Delta = 0$). It is possible that flame failure, if it occurs, could go undetected for 1 hr. The maximum acceptable concentration for prolonged exposure, including 1 hr., is assumed to be 25 ppm. by volume.

How high should the flare stack be? Use a stack gas speed of 70 ft./sec. (flare tip I.D. = 7 in.) and ½ of the maximum allowable velocity rise.

Solution—Since we are only using ½ of the maximum velocity rise, $a = 1$. Q_{T1} is 20 cfs. and Q_m is 15 cfs. Then,

$$(a)\ (Q_{T1}\ C_o/Q_m)^{0.5} = 5.8$$

Enter Fig. 1 with $v_s = 70$ and the 5.8 value for the concentration function (as shown in color on the chart) and note that

$$h_s\ (C_o/Q_m)^{0.5} = 225$$

Solving for h_s gives the answer of 175 ft. From Fig. 2, the critical wind speed is 1.5 ft./sec which is 1 mph. Then, the highest concentration from the 175-ft. stack will occur with a 1-mph. wind. With a wind speed of about 1 mph., ½ h_s max. (from Eq. (5) is 58 ft. and the effective stack height would be 175 plus 58, or 233 ft.

The location of the maximum concentration of 25 ppm. at the ground ($x_m = H/2p$) will range from 1,165 ft. for an unstable atmosphere ($p = 0.1$) to 2,330 ft. for a neutral atmosphere ($p = 0.05$).

It has been shown that peak 1-min. concentrations are about 10 times the 30-min. average.[4] In the distance range, 1,165-2,330 ft., peak 1-min. concentration might reach as high as 250 ppm.

Problem 2 (*High Stack Gas Exit Speeds*)—2,400 cfm. of a nitrogen mixture, containing 50% of a combustible and potentially toxic waste gas, are to be burned in a flare stack. The gas has a molecular weight of 29 and is at ambient air temperature ($\Delta = 0$). It's possible that flame failure, if it occurs, could occur for 1 hr. The maximum acceptable concentration for prolonged exposure to the waste gas is assumed to be 25 ppm. by volume. But no more than 150 ppm. can be tolerated for 1 min. How high should the flare stack be? Use a stack gas speed of 200 ft./sec. (flare tip I.D. = 6 in.) and ½ of the velocity rise.

Solution — The 30-min. average concentration, corresponding to a peak 1-min. concentration of 150 ppm., is 15 ppm. We must use Eq. (7), since v_s is larger than 80. We know that $a = 1$; $Q_{T1} = 40$ cfs.; and $Q_m = 20$ cfs. Therefore, $u_{cm} = 1.0$ and we'll use 1.5 ft./sec. as our critical velocity.

Then,

$$h_s = \frac{2.38\ a\ (Q_{T1}\ v_s)^{0.5}}{[1 + (0.43 u_{cm}/v_s)]\ (u_{cm})}$$

$$= \frac{(2.38)\ (1)\ [(40)\ (200)]^{0.5}}{[1 + (0.64/200)]\ (1.5)}$$

$$h_s = 142$$

Since,

$$h_s = \frac{(1.35\ Q_m \times 10^5)^{0.5}}{(u\ C_o)^{0.5}} - h_s - h_t$$

Therefore, the height of the stack will be:

$$h_s = 348 - 142 - 0$$

$$h_s = 206 \cong 200 \text{ ft.}$$

Peak concentrations from the 200-ft. stack will occur in the distance range of 1,710-3,420 ft. downwind of the stack with a wind of about 1 mph.

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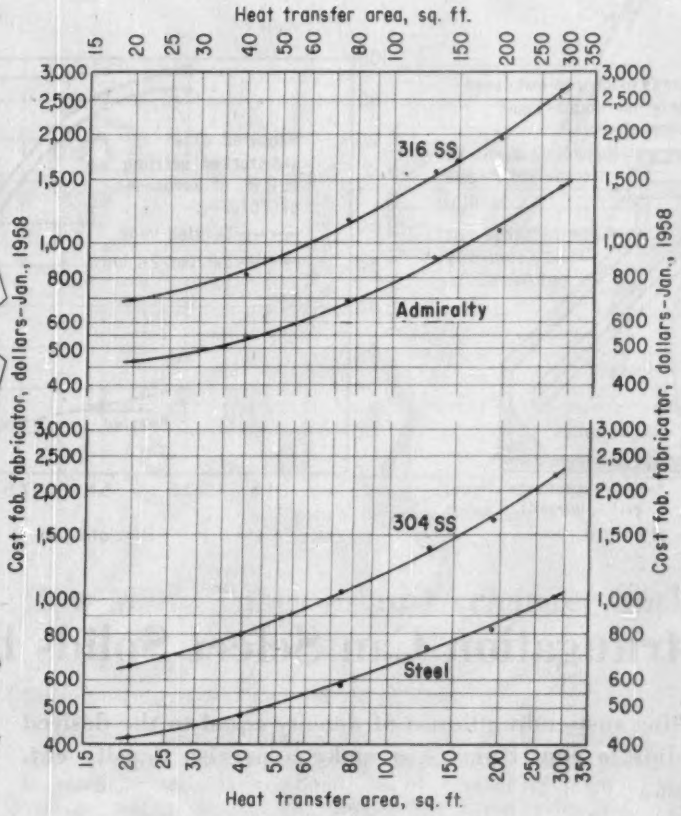
Heat transfer area, sq. ft.
15 20 25 30 40 50 60 80 100 150 200 250 300 350
3,000 2,500 2,000 1,500 1,000 800 600 500 400
316 SS
Admiralty
304 SS
Steel
Cost fob. fabricator, dollars-Jan., 1958
Heat transfer area, sq. ft.

Whitlock, U-tube Kettle Reboilers

Type "KR"

Steel tubes
3/4" OD x 16 BWG; 1" pitch
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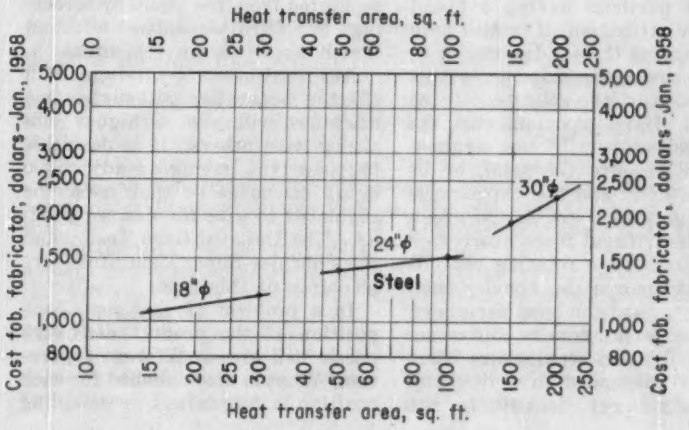
Heat transfer area, sq. ft.
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5,000 4,000 3,000 2,500 2,000 1,500 1,000 800
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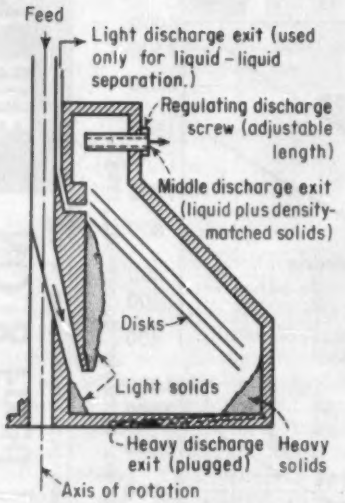
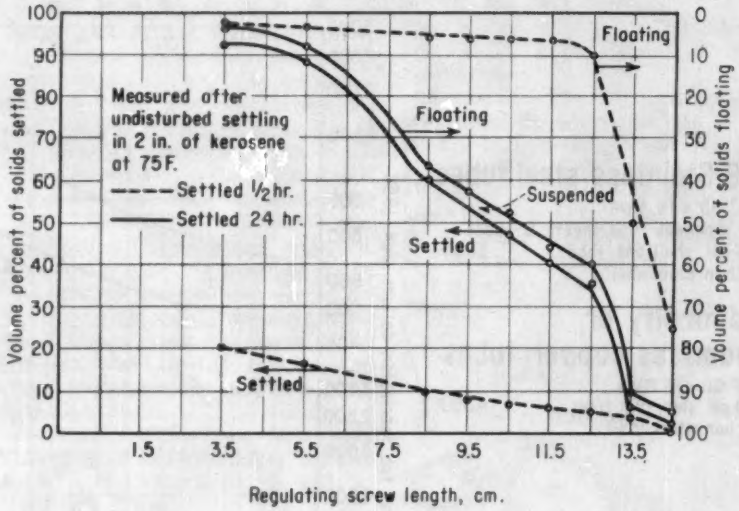
Steel
Cost fob. fabricator, dollars-Jan., 1958
Heat transfer area, sq. ft.





Centrifugation Can Select Solids by Density

Using suspending liquid of density equal to the desired solids, a centrifugal can make a precise density cut.

Merton Allen

Chemical Engineer, General Engineering Laboratory, General Electric Co., Schenectady, N. Y.

Centrifugals are normally used for liquid-liquid and liquid-solid separations. However, by a method discussed here, a suitable continuous centrifugal can also be used to separate solid particles having a narrow range of densities from a mass of particles having a broad density distribution. The idea here is to disperse the solid particles in a liquid having the same density as the density of the solids cut to be removed. It is important that the liquid chosen should not agglomerate or dissolve the solid, or be adsorbed by it, and that the particle size range should not be too great.

The centrifugal force exerted on the contents of a rotating centrifugal bowl moves the heavier components toward the bowl periphery. If there is no density difference there will be no separation. When a slurry suspended in a liquid of the desired cut density is run through a continuous machine, particles heavier than the desired cut are thrown to the periphery while lighter particles move toward the axis. Particles which are close to the liquid density discharge with the liquid from the bowl, later to be separated from the liquid by screening or filtration. The lefthand sketch above shows the situation.

Any continuous centrifugal will effect a separation although some machines will give a higher efficiency than others. It is desirable to use a type having an adjustable liquid discharge so that it can be regulated to give the desired product. The DeLaval Gyro Tester and the Sharples Super Centrifuge are machines of this type.

In a problem of this sort, each position of the product discharge nozzle will give a different separation. What is accomplished for each position is determined by sampling the discharge and measuring the quantities of solids which float, remain suspended, and settle in a given time in an undisturbed liquid column of known depth and density. When these data are plotted against the position of the liquid discharge, they can be used to find the proper discharge setting for a given product specification. The floating, settled and suspended material can then be determined by separation and filtration, or by light-scattering or turbidity methods.

As an example, here is a problem from actual practice. The product specifications called for:

1. Particles of density 0.800 g./cc. at 75 F. were to be separated from particles with a density spread of 0.7 to 1.0 g./cc.—a size range of 105-210 microns.

2. The product density should have little spread, as measured by the fact that at least 85% of the particles should have less than a 4-in./hr. rising or settling velocity when dispersed in a liquid of 0.800 g./cc. density. (Stokes' law shows this as a very close density cut.)

3. The product particles should have a density distribution such

that half would be lighter and half heavier than 0.800 g./cc. That is, given sufficient time, half should rise, half sink.

We found initially that only 2% of the particles in the 0.7 to 1.0 g./cc. range met the 4 in./hr. rising or settling specification. We did not know how this 2% was distributed.

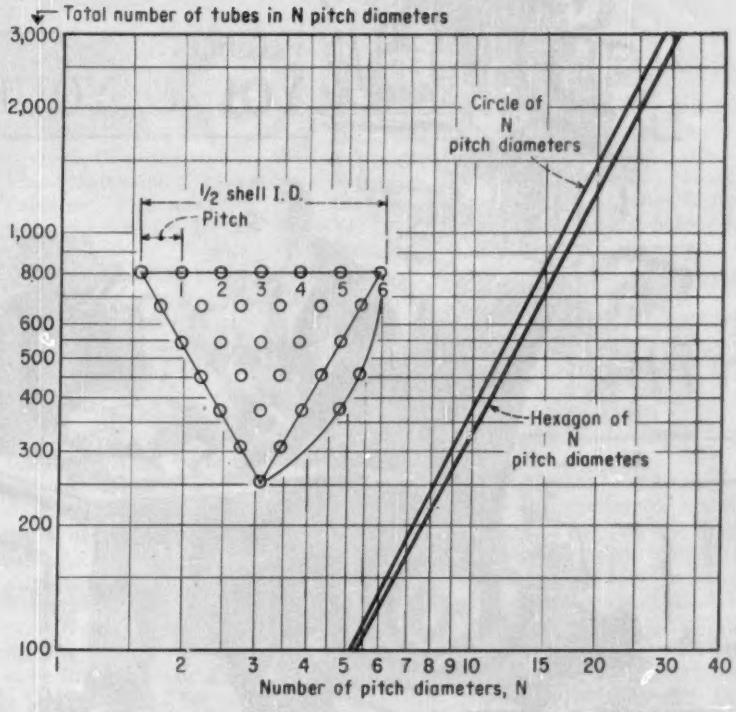
To make the separation we chose kerosene having a density of 0.8006 g./cc. as the dispersing liquid. It does not dissolve, agglomerate or adsorb on the solids.

Our first tests were aimed at finding the position of the discharge nozzle which would give a product having at least 85% of the particles close enough to 0.800 g./cc. so that they would settle or rise less than 4 in./hr. The dotted curves in the plot are for this test. The discharge was sampled at nine settings and each sample settled undisturbed for 0.5 hr. in 2 in. of kerosene at 75 F. This is equivalent to 4 in./hr.

Observation of the dotted curves shows that discharge screw settings from 7.5 to 12.5 cm. give a product approximately 85% suspended in the settling test, but this does not show how the product densities are distributed. Since very few of the particles have exactly the density of the kerosene, a longer settling period will either float or sink most of them and enable us to find the discharge setting giving the desired distribution.

Another series of similar tests, but with the settling time 24 hr., is plotted in the solid curves. Now it appears that a discharge setting of 10.5 cm. will give roughly 50% risers and 50% settlers, which matches the specification that half the product should be heavier and half lighter than a density of 0.800 g./cc.

These tests have shown that centrifugation provides a good means of separating a narrow density cut of solid particles from a broad distribution of particle densities. The method is simple and rapid but it does require running tests to determine the optimum operating conditions for each separation. With these, by suitable choice of the suspending liquid, and by proper adjustment of product discharge diameter, the desired product density cut and density distribution can be secured without difficulty.



How Many Tubes in an Exchanger Shell?

Ronald L. Senn

Union Carbide Nuclear Co., Oak Ridge, Tenn.

Design of heat exchangers normally requires several calculations to reach an optimum combination of tube length, number of tubes, and shell diameter, for any given amount of heat exchange surface. The chart above simplifies such calculations.

The chart is based on triangular tube array and is plotted in terms of number of pitch diameters *N*. One curve gives the number of tubes in a hexagonal arrangement, the other in a circular arrangement of *N* pitch diameters. The diagram shows the tube arrangement.

NEXT ISSUE: Water Still Regulates Itself Automatically

By H. Leslie Bullock, Winner of the October Contest

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YOU & YOUR JOB

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Get a Job From the Man Who Owns One: The

Next time you make an important change in your career, follow this outline and you'll stand a good chance of landing the job.

R. J. Obrochta, Personnel Engineer, Convair (San Diego), Div. of General Dynamics Corp.

A job interview is hard work, both for you and the employment interviewer. Although there is no guarantee that hard work alone will get you a job, here are a few inside tips that will increase the odds in your favor if you follow them the next time you are interviewed.

When you ask for a job, the key word is anticipation. Know what is coming up before it comes up. If you had a copy of the questions and answers for a television quiz show, you'd stand a good chance of winning the jackpot. Likewise, if you can anticipate the questions of the employment interviewer, you stand a pretty good chance of "winning" the interview.

Ideally, if you could, you should have a few "warm-up" interviews before the big one. Try for the $64 before you go for the $64,000. Naturally, this isn't always possible; but if it is, it's worth a try. Besides, if you win a job that's not exactly the one you want, it will give you a confident feeling for subsequent interviews.

Some of the best interviewees, for example, are the young engineers just graduating from college. They have been through a number of employment interviews by a wide assortment of company representatives. They know what to expect and have developed good interview skills either consciously or unconsciously. They are in practice.

Another man who is in practice is the "job-hopper." The employment interviewer could find him to be a most astute applicant. The job-hopper is interview-wise; has a lot of interview-hours under his belt; and oftentimes knows the answers to questions even before the interviewer asks them. On the other hand, the person who has enjoyed a comfortable, successful job situation often appears less sophisticated because he does not quite know how to conduct himself. The interview can be a real ordeal for him.

However, with a little preparation, he can find the interview game challenging and—better yet—profitable.

Describe Your Know-How

Fundamentally, there are three steps in describing your job experience and background to an interviewer:

- Give a general description of the company that now employs you.
- Describe your department or group.
- Give a detailed description of your personal job responsibilities.

If you give this information to an interviewer in a clear and con-

Interviewer

cise manner, he will be in a position to render an accurate evaluation of your qualifications. He'll be able to judge whether or not your background coincides with the position or positions his company has available.

A general description of a company should be brief but informative. Tell what industry the company is in; its products and services; and its general organization and operations. If you work for a well-known, large company, describe the particular division which employs you, along with its specific products and operations. Many chemical process companies are so huge and diverse that an applicant should not expect an interviewer to be able to pinpoint the exact nature of the products involved by merely mentioning the company's name.

A general description of your department should include its overall functions; level of operations and echelon authority; and its "reason for being." All of this information, given simply and briefly, will set the stage for presenting the main attraction: your job responsibilities.

Open this description with one broad statement of your general job function. For example, "As the technical director for the materials test laboratory, I am responsible for all the testing of materials and metals used in our company's products; I supervise 25 employees, six of whom are research chemists and engineers; and I also administer an annual budget of $800,000."

This short statement immediately gives the interviewer an image of what your position and responsibilities are. You can then follow this up with a detailed account of your assignments, special projects, the peculiar problems you solved and other related facts. Bring out any pertinent cost reductions, research findings or operating improvements in which you were instrumental.

One caution: Don't sound like a one-man band.

Aim for THE Job

Your presentation of the personal responsibilities you have had is very important and should be as specifically directed toward the job for which you are applying as possible. Often, a person reaches a point in his career where his experience is so broad that he can qualify for several positions in related fields or for several different jobs in the same field.

As a result, given enough information about a job, he can select "pieces" of his experience background, emphasize them in his interview and resume and "qualify" for the job.

These are no little white lies by any means; rather, you are selling yourself and you should bring out strongly and keenly that background of yours which fits the job. Relegate your other experience to a secondary position. You may be quite proud of the fact that you flew dive bombers during the war, but don't clutter up the interview with your heroic exploits unless:

1. This experience is pertinent to the job.

2. The employment interviewer flew dive bombers too.

It follows then that the more you can learn about the job requirements before the interview, the better you can present your story to an interviewer. This is especially the case in administrative and executive jobs. Perhaps the following example of how one applicant missed out because he failed to find out enough about the job before he applied will illustrate the point.

Profit from Other's Errors

This applicant asked for the position of field service representative. The job description called for two main qualifications:

1. Public-contact ability.

2. Technical knowledge of organic chemistry.

Our applicant had been employed in the chemical industry for almost 15 years and had held various positions. It seemed quite possible, therefore, that he had acquired some of the experience that the field representative job required.

During the interview he displayed personal characteristics which appeared desirable for the job. He was then asked to describe his technical background. This question apparently took him by surprise because he gave an unconnected, superficial account of his experience. The interviewer was not able to evaluate the man's technical competence and was reluctant to consider him further.

Had the applicant anticipated the interview questions and had he gathered more specific information about the job before the interview, it's likely that he could have turned out to be a more serious candidate. He could have assembled the salient "pieces" of his background and emphasized them during the interview. (In this particular case, he had the opportunity to check on the requirements of the job before he was interviewed.)

Even one week later we received a letter from this applicant in which he added some further experience which he "neglected" to mention during the interview. At this particular point though, the interviewer had cooled off and felt that the applicant was being too obvious in "blowing up" some experience to get the job.

Knowing as much as possible about a job before you apply for it is an extremely important point. It sometimes gets to be a cat-and-mouse game because the applicant essentially says, "Tell me about the job and I'll tell you what I've got,"

while the interviewer is saying just the reverse.

The employment interviewer really has an ace in the hole when he interviews you and learns that you have only a vague idea of what the job is about. You may be able to tell him that you know how to play baseball, but you're not sure if he's looking for a first baseman or a catcher.

Find out. Once you do, you can either tell him how well you throw left-handed or how well you can handle pitchers.

Tell a Threefold Story

By telling your threefold story—company, department, job — you start with a good foundation to build upon. It might very well be that the employer has several openings in the general field in which you are qualified. These jobs may be at varying levels of responsibility and with varying degrees of future development.

Your logical presentation of your qualifications could place you in one of the higher echelon positions. On the other hand, if there's only one position open, your integrated story may make you a winner over other applicants instead of an "also ran." In either case, you are ahead.

Aside from what you tell the interviewer, it's important how you tell him. The manner in which you verbalize, emphasize and pace your threefold story will vary from one interviewer to the next. Even though you tell Aunt Susie the same story you tell your neighbor, the twist might be a little different.

Same with the twist you give in your employment story to the interviewer. Recognize the many, almost indefinite goals that the interviewer consciously or unconsciously strives toward during the interview, and help him achieve them.

If you do this, he'll feel that you are a good candidate for the job.

R. J. OBROCHTA, 33, *has been personnel engineer at Convair (San Diego), a division of General Dynamics Corp., for three years. He is a graduate of Loyola Univ., Chicago, where he received a B.S. in* 1950 *and an M.A. in industrial clinical psychology in* 1955. *A Marine Corps veteran, Obrochta is a member of the American Psychological Assn. and the San Diego Human Engineering Society. He has six children, three boys and three girls.*

Tricks of the Trade

There are tricks to all trades, and employment interviewing is no exception. For example, even though you present a resume of your experience and background, the employment interviewer may still ask you to reiterate this information. It may be that he wants to evaluate your voice quality, verbal expression, grammar or perhaps get a better idea of what your work experience has been.

Sometimes, too, resumes are prepared by people other than the applicant himself and the personality generated from one is quite different from that of the other. Occasionally, an interviewer will bring up irrelevant topics during the interview. He may be trying to place you at ease. On the other hand, he may be testing to see if he can detour you from talking "job" to talking "football."

If an interviewer can lead a sales applicant astray, it's conceivable that a customer could do the same and the sales order would never be written.

Playing the Hunch

Sometimes interviewers get hunches about an applicant and then proceed to test them out.

One applicant, for example, was being interviewed for the position of administrative chemical engineer for a Midwest firm. The job paid $11,000/yr. and called for a graduate engineer who could understand the operation of equipment to be used in industrial chemical processing. It was especially important that this man have a personal approach with people since he had to perform a liaison task between customers and design and production engineers.

The applicant being interviewed for this job seemed to have the technical training and experience. However, the interviewer had a hunch that this man was not as easy going as he claimed and appeared to be.

At one point during the interview, the applicant boasted that he always got along with people, one of the reasons being that he never discussed two topics: religion and politics. The interviewer seized this opportunity to play out his hunch and purposely disagreed with the applicant and then led him into an animated discussion of religion and politics.

Dirty pool, you might say? Hardly. If the applicant had any insight into social situations and human behaviour, he would have tactfully veered away from the interviewer's prodding.

Another applicant told an interviewer that he never lost his temper. The interviewer immediately proceeded to misinterpret and exaggerate the applicant's subsequent remarks and the applicant almost as immediately started to lose his temper. This told the interviewer at least one of these things about the applicant: he was human; he deliberately tried to mislead the interviewer; or, he actually believed that he never lost his temper.

Supplement With Common Sense

In summary, a lot of the problems of being interviewed can be licked if you anticipate and are prepared to tell your company-department-job story. Supplement this with common sense judgment and you will do your best.

If you are asked to take psychological tests, don't expound on what you think of testing—unless you are prepared to take your hat out of the job ring. Likewise, don't say you are leaving your company which employs 1,000 people because it's too big, when the company to which you are applying employs 30,000. You would also not tell a GM interviewer that Ford puts out the best car on the market, then give ten reasons why.

The next time you make an important change in your career, approach the interview as we have outlined and you will stand a good chance of landing the job you want. Your anticipation will change to satisfying realization. That job may be your job.

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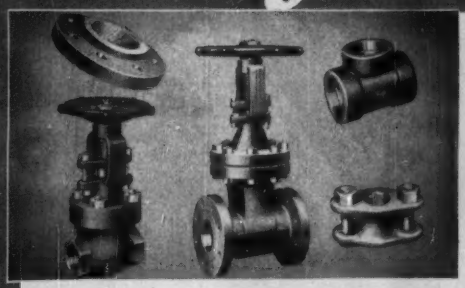

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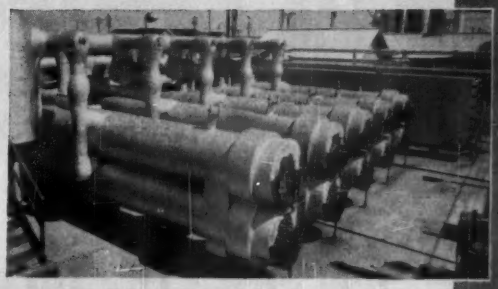

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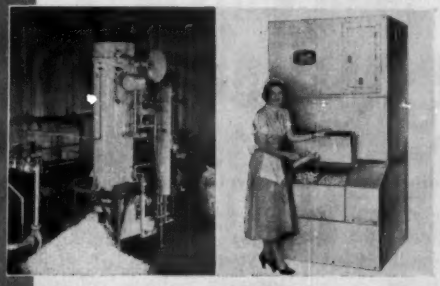

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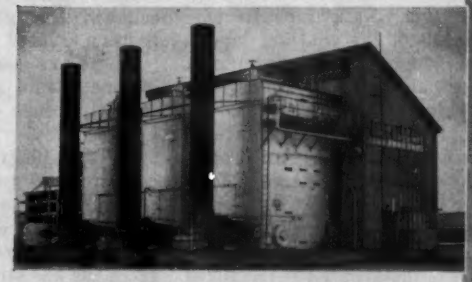

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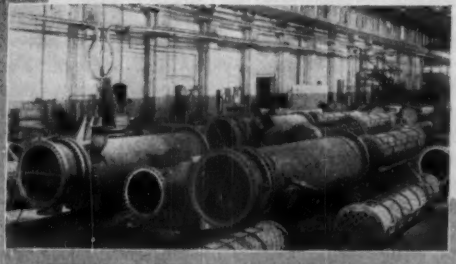

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Troubleshooting Dust Collectors

W. E. ARCHER, Chief Development Engineer, Western Precipitation Corp., Los Angeles, Calif.

You can't reduce the maintenance of mechanical dust collectors to a fixed formula. Variations in material collected, installation, layout and operating and maintenance techniques all seriously affect collector performance.

You'll find your best solutions through a common-sense approach and a knowledge of fundamental operating principles.

In doing this type of troubleshooting, one of your best interpretive tools is imagination—tempered with judgment. In effect, you are a detective, searching for clues that indicate potential trouble spots.

Understand the Principles

You need a sound understanding of fundamental operating principles before you can interpret any evidence on dust collectors. Look at the diagram on the next page where the main components of a conventional multiple-tube mechanical collector are shown. This type of unit is often called a cyclonic collector because of the high rotational-velocity pattern created in the tubes.

There are four elements to a collector: a spin producing device, a collecting tube, an outlet tube and a hopper.

In the illustration, a vane accelerates and rotates the gases passing through each tube. This vortical action provides a centrifugal force to separate suspended dust from the gas stream.

Actual separation of the suspended dust is in the collector tube. Dust forms in a concentrated layer at the periphery of the vortex, near the tube wall, and is expelled from the bottom of the tube because of a large pressure gradient.

Clean gases leave the collecting tube through an outlet tube. Gas flow is designed so the entire stream passes through a bank of tubes operating in parallel. The hopper is usually common to a large number of tubes. Deposited dust is removed from the hopper by a dust handling system.

Duct Design Affects Efficiency

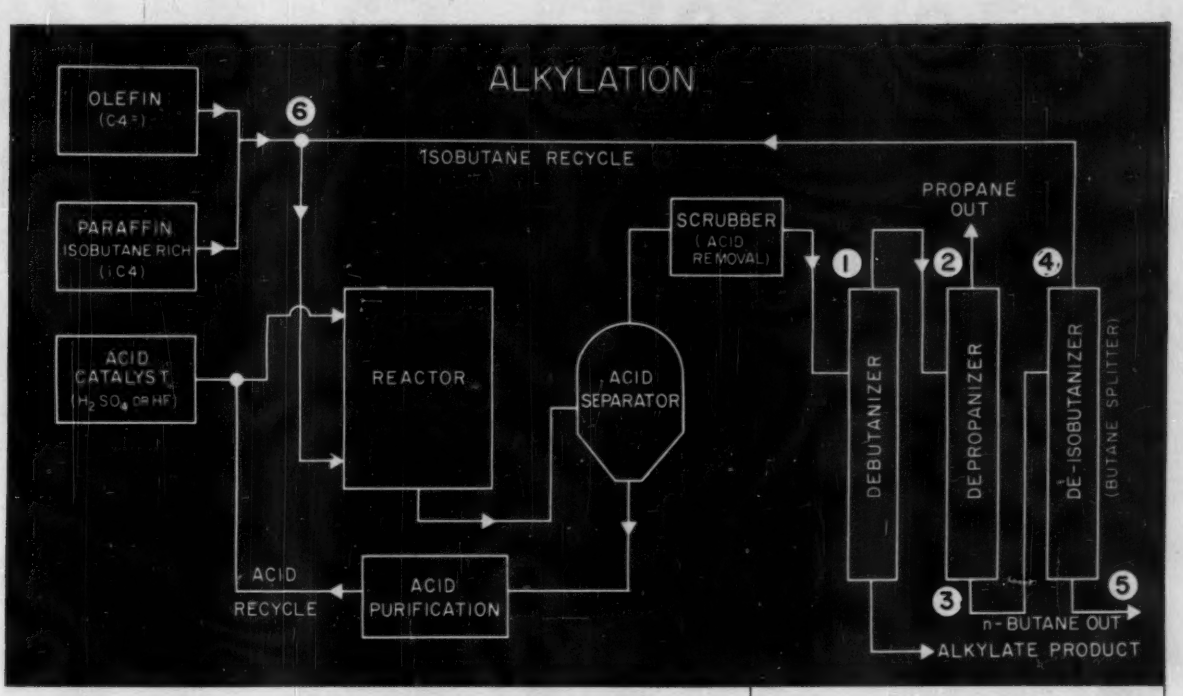
Poor design of a duct system greatly reduces collector efficiency and imposes extra wear. For operation at peak performance with minimum maintenance, your design must keep dust and gas distribution as uniform as possible.

Dust concentration in certain areas of a duct is often many times the average dust concentration in the gas stream. Still, it's very important for this area to have a satisfactory gas flow pattern. For highest collection efficiency, your duct design must balance these two parameters.

Poor distribution is usually caused by settling of heavier dust particles during a long, straight run, or segregation of the dust and gas because of changes in direction. These changes in direction bring about greater inertial forces on the dust and separate it from the gas stream. That's why, an improvement in gas flow patterns may be detrimental to dust distribution.

By creating turbulence in a gas

This article is based on a paper delivered at the ASME annual meeting in New York, Nov. 30—Dec. 5, 1958.



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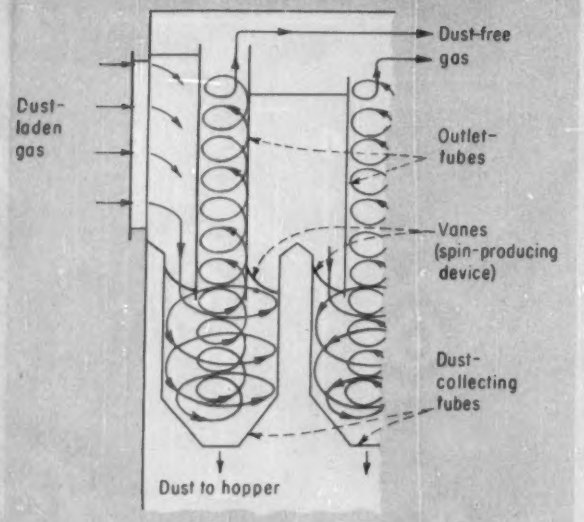
Basic Operating Principles



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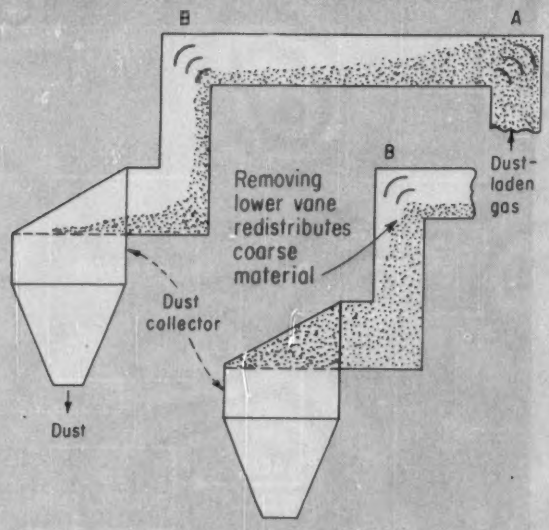

stream, you redistribute the dust particles but also increase the pressure drop. You must consider both gas and duct behavior together.

An excellent example of what happens when you change gas stream distribution is shown above. Here, ducting leading to the inlet of a dust collector is illustrated.

Internal inspection of this unit was made after an initial period of operation. This inspection showed the turning vanes at the first 90-deg. turn (*A*) satisfactorily reduced gas turbulence.

In the long, horizontal run through the duct, the larger particles settled giving a heavy concentration just above the floor. This was determined by the abrasion pattern on vertical structural columns and substantiated later by filtration tests.

At the second change of direction (*B*), a double 90-deg. turn to the inlet of the dust collector, the gas changed direction with a minimum of turbulence. However, at the turning vanes, the coarser material passed under the lower vane and was further stratified by the second turn. Result: unusually severe wear on the upstream half of the collector.

Solution: remove the lower vane at turn *B*. Turbulence is created that redisperses the coarse material. Later inspection showed this change quite effectively and uniformly distributed the gas load.

Any uniform restriction across the gas stream, with a resultant pressure drop, improves the velocity profile or gas distribution. However, the dust particles have more inertia than the gas stream and a restrictive gas distribution device has little effect on dust distribution.

Perforated plates are often used as restricting devices. Very effectively, the collector itself—a number of small diameter cyclonic tubes operating in parallel—accomplishes the same purpose.

When you're making an internal inspection of a collector, any indication of uneven dust distribution should be your first concern.

Concentrations of large dust particles polish and erode the metal in a clearly defined pattern. Fine dust, on the other hand, adheres and builds up on steel and reveals a great deal about turbulence and flow patterns. Build-ups of dust on the floor of a duct show areas of low velocity.

Turbulence can be induced by removing turning vanes or adding obstructions to the gas stream as baffles. If you use baffles, design and locate them by the dust concentration pattern and velocity of the gas stream. Determine the amount of obstruction presented by the baffle from the pressure drop.

Reduce Hopper Circulation

Baffles are sometimes installed in the hopper to reduce gas flow. These baffles divide the tubes in half, in the direction of gas flow. They're sealed around the sides and to the collecting tube sheet and extend within a short distance of the hopper outlet. As dust settles from the collecting tubes, the hopper is sealed into two separate chambers.

In passing through the collector, gases must pass through a number of tubes or equivalent ductwork to reach or leave the collecting elements. As gas enters the collecting vanes, the pressure isn't equal throughout and further inequality occurs because of varying lengths of outlet tubes and losses in the outlet header. In a common hopper, appreciable currents are set up as the gases attempt to equalize these pressure differentials.

Ideal solution to this problem is individual hoppers for each collecting tube. Since this is usually economically unfeasible, a hopper baffle is used to reduce the circulation.

Since most dust collectors operate under negative pressure, air leaking into the hopper contributes to poor collection efficiency. This occurs through leaking dust valves on the hopper exit, flange joints and access doors.

Similar leaks occur at joints between the collecting tube and the collecting tube sheet. In this case, gas by-passes the vane and the collecting tube to enter the hopper.

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tion to the inlet pressure. If these conditions exist to a sufficient extent, certain areas of the collector may cease functioning.

Pluggage: Major Problem

Difficulties often come from solid building-up of materials and plugging of the components.

One serious effect is the vane or spin-producing device becoming plugged. When this happens, a dust seal isn't created in the collecting tube by incoming gases. Result: an open passageway between the hopper and the outlet housing through the collecting and outlet tubes.

There's always a dense concentration of suspended dust in the hopper. This concentration may be many times greater than the dust concentration in the main stream entering the collector. As a passageway to the outlet housing opens, hopper dust is pulled into the stream of cleaned gas.

Plugging of one collecting tube inlet removes more material from the hopper than many properly operating tubes collect.

High vane-velocities are necessary in any mechanical collector. As a result, the passageways are small in relation to the gas volume. Under ordinary circumstances, there's little tendency toward pluggage in these small cross-sectional areas.

However, sticky materials that adhere on impingement cause difficulty. These materials build-up on duct walls, on the underside of the outlet tube sheet and on the outlet tube face. They then break away and fall into the vanes clogging them.

If you discover this situation, clean the vanes carefully at every opportunity. If possible, take steps to correct the circumstances producing this condition.

An effective countermeasure is maintaining gas temperatures above the dew point. This prevents agglomeration.

Most common type of plugging you'll find is in the collecting tubes —usually caused by overfilling the hoppers. Here, the dust level rises in the hopper and finally closes off the bottom of the collecting tubes. Dust builds up in the tubes until equilibrium is reached. At this point, the velocity is great enough to carry incoming dust through the tube and straight out through the outlet tube.

Evacuating the hopper after this happens may not clear the tubes. If the dust packs during overfilling it's possible for the tubes to remain plugged after the hopper is emptied.

If the tubes aren't cleaned out, very serious wear occurs because the top dust layer rotates at high velocity in one localized area of the collecting tube. Clear the tubes by rodding or air lancing.

Collecting tubes sometimes plug in normal operation. Solution: install a method of vibrating the collecting tubes periodically.

Outlet tubes rarely plug in normal operation. Only exception is when both the vane and collecting tube are plugged. In this case, the outlet tube eventually fills with dust. This isn't serious since the tube is completely out of service. However, if a number of tubes become plugged, the pressure drop across the collector increases and efficiency decreases.

One solution to plugged outlet tubes is suspending a chain in the center of the tube. The swirling gas stream swings the chain and scrapes the tube walls clean. Loosened material falls through the collecting tube directly down into the hopper.

Dust Disposal Problems

Slight amounts of moisture in collected dust causes it to pack into an inert mass. Continuous or more frequent dust disposal helps prevent this problem, but insulation is usually more effective in removing the cause.

It's important to insulate the hopper when gas temperatures are near the dew point. In severe cases, heating the hopper walls may prevent condensation.

Where dust is very fine or has a great deal of cohesion, vibrators improve the removal of dust from the hopper but must not damage any insulation. Vibrating an internal hopper baffle or an auxiliary baffle located near the outlet of the hopper can be almost as effective as vibrating the hopper.

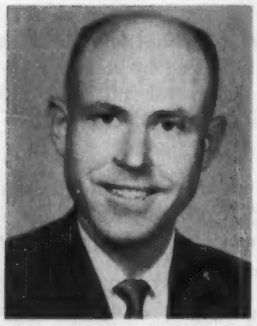
Aeration, if used carefully, also aids hopper evacuation. However, misuse of this method is common. Too much air reentrains the collected dust. Leaving an air lance on for prolonged periods reduces performance and causes severe abrasion in the immediate area of the air blast.

Distribute Wear Evenly

Erosion in a mechanical collector is usually in two forms: Impingement wear at the inlet of the unit and erosion of the collecting tubes and vanes.

Dust distribution in the duct is shown by impingement wear at the unit inlet. Poor distribution causes severe erosion in localized areas. If dust distribution is satisfactory and erosion is still a problem, the only solution is to provide sacrificial material for protection. This is usually done with replaceable angles and plates that absorb the worst of the wear.

For maximum service with minimum maintenance, under abrasive conditions, wear must be evenly distributed over the entire group of tubes. Special alloy materials of construction may be called for under extreme conditions. Castable ceramics and a combination of special alloys are sometimes required when high-temperature abrasion occurs.

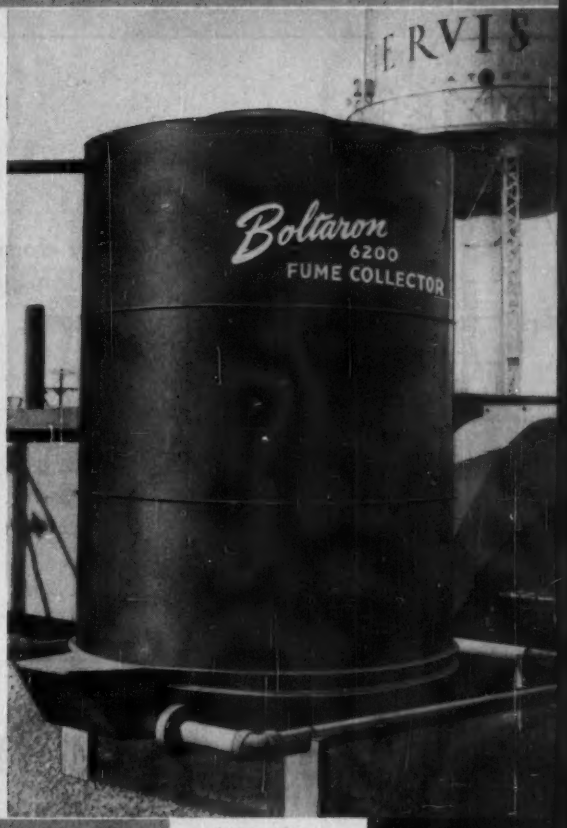


W. E. ARCHER, *a native Californian, has been with Western Precipitation Corp. since* 1950. *In the past eight years he has held various posts in both their New York and Los Angeles offices with two years out for the armed services. Archer spent this time at Redstone Arsenal in Alabama. He received his BS in mechanical engineering in* 1949 *from Cal Tech and is a member of the ASME. Currently, Archer is in charge of the development group of Western's research and development department.*

The Carpart Corporation proves . . .

BOLTARON 6200 exhaust-system

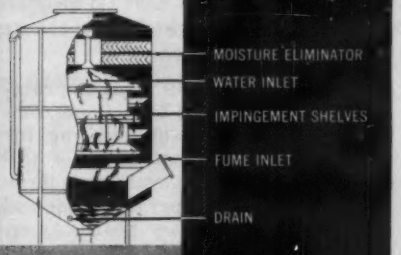
BOLTARON 6200 fume separator



Boltaron 6200

is the best answer for low-cost exhaust-systems & fume collectors

Cut-away view of Carpart's BOLTARON 6200 fume collector



Exhaust systems and fume collectors fabricated from BOLTARON 6200 outlast stainless steel, plastisol coated and fiberglass in handling acid and alkali fumes. BOLTARON 6200 fume collectors cost less than stainless steel . . . are corrosion resistant . . . maintenance free . . . 98.9% effective in removing soluble acids.

For further information on performance-proven fume collectors & exhaust-systems write: Carpart Corporation, 209 West Exchange St., Owosso, Michigan.

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Why settle for less?

	Type 316	D319	
			Recently approved by the ASME Boiler and Pressure Vessel Committee for direct replacement of Type 316.
Cr	16.00–18.00%	17.50–19.50%	Higher chromium and nickel contents insure better over-all corrosion resistance, compared to 316.
Ni	10.00–14.00	11.00–15.00	
Mo	2.00– 3.00	2.25– 3.00	Increasing minimum content of Mo boosts corrosion resistance, particularly to acids.
C, max	0.08	0.07	
Mn, max	2.00	2.00	
Si, max	1.00	1.00	
P, max	0.045	0.045	
S, max	0.030	0.030	

New Stainless Better Than Type 316

An improved stainless—D319—with superior corrosion resistance is strongly bidding to replace Type 316 in chemical process equipment.

Stainless D319, a big improvement over Type 316, is now commercially available, waiting for chemical applications.

A recent report to the chemical industry by the Chemical Industry Advisory Board, American Standards Assn., puts it more bluntly: "D319 offers improved general corrosion resistance over Type 316. It's Code approved. Let's use it."

▶ **More Resistant**—Type 316 is one of the workhorse stainless steels in chemical processing. But, for example, it is susceptible to some acid (sulfuric, formic, phosphoric) corrosion. So D319, with a higher chromium and molybdenum content, as the table above shows, is more resistant to this attack. Also, with a higher Mo minimum content, D319 should be more resistant to pitting and pinhole corrosion.

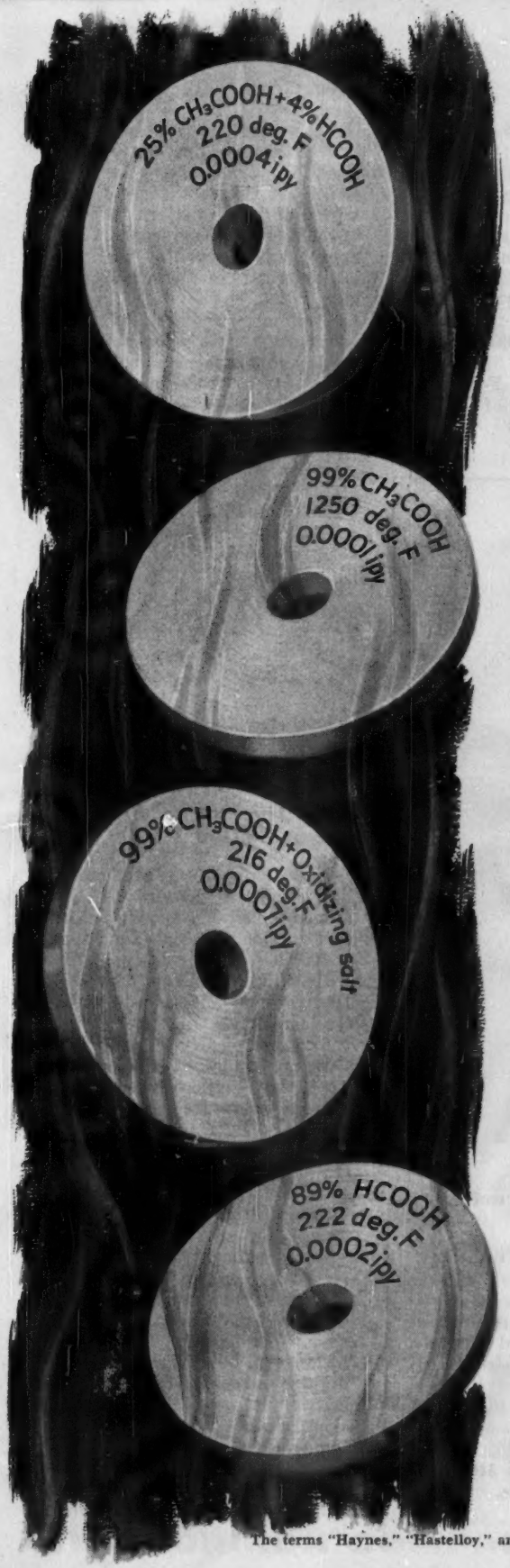
Costs are slightly higher (up to 2¢/lb.) compared to 316, but this difference should be decreased as larger quantities of D319 are produced.

CIAB, in cooperation with the steel industry, has been working hard at bringing the new molybdenum-bearing austenitic stainless steel alloy into commercial production—spurred on by increasing demand by the chemical industry for special modifications of the AISI Type 316 alloy to improve general corrosion resistance. Usually a higher chromium content was sought, but wide variations in the content of other elements in Type 316 bothered many people. Modifications of the standard analysis weren't available from warehouse stocks. So asking for modified heats of 316 usually involved delays in delivery.

The chemical industry was surveyed to establish requirements of Cr-Ni-Mo stainless steels, and sufficient demand from a substantial number of consumers, both large and small, for a new standard alloy quickly became apparent. A special CIAB subcommittee working jointly with AISI stainless steel technical committees decided upon a new producible alloy.

▶ **Developmental Alloy** — The number, D319, was assigned by the American Iron and Steel Institute. It is known as a "development" alloy, and was so designated pending making of a tonnage survey now scheduled for 1959. When a large enough demand develops, the new stainless steel will be AISI Type 319.

Actually, according to CIAB, many of the special modifications of Type 316 purchased and used



Organic Acids Causing Corrosion?

...Test **HAYNES** Alloys

HASTELLOY alloy C and nine other corrosion-resistant alloys were tested in hot acetic acid vapors containing traces of oxidizing contaminants. HASTELLOY alloy C had a penetration rate of only 0.0007 inches per year—lowest among all nine competitive alloys. Others varied from 0.005 to 0.5 inches per year and were severely pitted. This test showed one manufacturer of organic chemicals how he could keep his maintenance costs to a minimum before a process was even on stream.

How much money can you save in your plant? Why not find out for sure by testing HAYNES alloys.

We'll gladly send you samples. There are 6 HAYNES corrosion-resistant alloys. To help us select the one most likely to solve your problem, we suggest that you send us a letter outlining the corrosive conditions in your plant. To learn more about HASTELLOY alloys, ask for a copy of our 104-page book. It describes the alloys in detail.

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by the chemical industry fall within the analysis range of D319. As much as 15 years service experience has been reported, and this experience is all good. So stainless D319 is not a new and untried alloy, but the result of an intense cooperative effort to make an alloy of improved characteristics and broader service utility.

Those responsible for the project suggest that users of Type 316 (or special modifications) consider using D319 for better corrosion resistance; where you want to avoid product contamination; or where you need fast deliveries. Because of the many variations in process conditions, no blanket recommendations can be made for specific new service applications. This type of information can be developed through an individual company's own testing procedures.

► **Code Approved** — Formal approval for the use of D319 in Code construction has been obtained through Special Ruling, Case No. 1254, issued by the Boiler and Pressure Vessel Committee of The American Society of Mechanical Engineers. This approval is covered by the following reply to the CIAB inquiry:

"September 2, 1958: It is the opinion of the Committee that a steel having a chemical composition as stated in the inquiry and designated D319 may be used for Code construction under all the rules applicable to Type 316 stainless steel. The allowable stress values for the regular Type 316 shall apply. The qualification of Procedure and Performance in Section IX for Type 316 shall apply."

One individual chemical company has determined that most principal stainless steel producers have stocks of D319 immediately available—some in ingot form; others in finished form, in both tonnage and reasonably minimum quantities.

Ductile Vanadium: New Material of Construction?

Vanadium of 99.5% min. purity is ductile and can be easily hot worked—below this purity V is very brittle. Now producing the pure material via new reduction processes, Vanadium Corp. of America offers extruded tube, rod and wire, rolled plate and foil (above).

With excellent corrosion resistance to HCl and H_2SO_4, V will also withstand aerated salt water attack better than most stainless steels—but not as well as titanium. Resistance to dilute caustic is fair, but V is attacked by HNO_3. Of special interest: ductile V retains its strength at high temperatures, and it has a low neutron cross-section.

As for costs, calcium-reduced vanadium metal (99.5% min. V) is available at about $40/lb. in irregular button form.

What Do You Use at 20,000 F.?

Materials engineers are searching the four corners of the atomic table in developing better construction materials for space travel.

Dr. A. R. Kaufmann, Technical Director and Vice President of Nuclear Metals, Inc., at a recent dedication of Nuclear Metal's Concord, Mass., metallurgical laboratory, gives us a sampling of what the future holds for new materials of construction.

He claims successful space travel requires development of materials which may be exposed to temperatures as high as 20,000 F. for short time periods. The highest melting point of substances now known is about 7,000 F., and there are only a small number of materials in this category. Very possibly space vehicles can be designed so the highest temperatures reached at critical places will not be greater than about 5,000 F. Even this temperature calls for going far beyond present engineering experience, since the highest temperatures commonly encountered in structural applications, other

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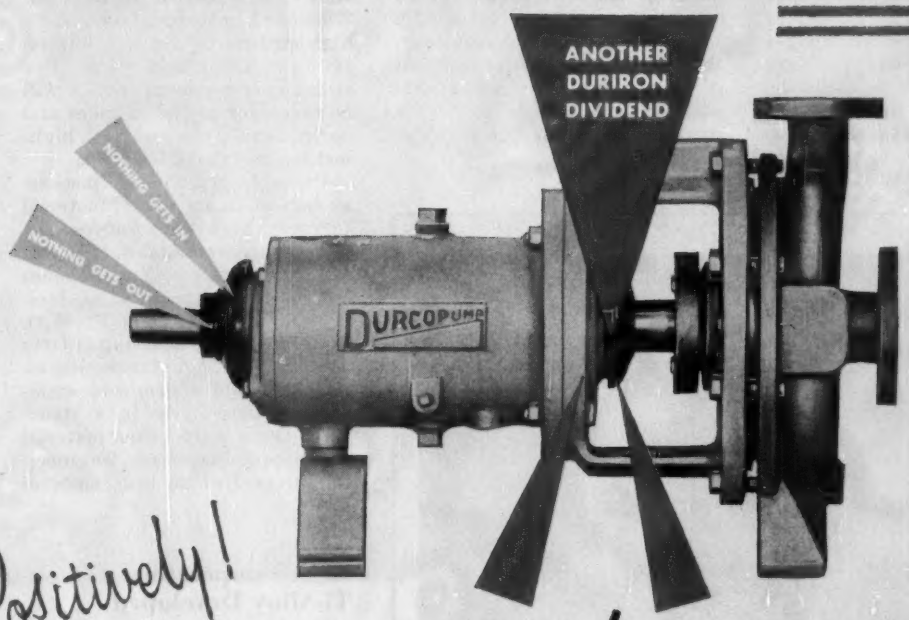

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than for furnace bricks and lamp filaments, are about 2,000 F.

There are many metals, such as tungsten, molybdenum, and tantalum, which remain solid to much higher temperatures than practically all of the ceramic materials. Some compounds of high-melting metals with carbon and boron have extremely high melting points. Another interesting substance of very high melting point is graphite. But most of the high-melting materials, especially the compound type, are brittle and subject to oxidation and other types of corrosion. Tungsten, molybdenum, tantalum, beryllium, rhodium, and their alloys and compounds, will need to be extensively developed before they can be used commercially at high temperatures. Then they will be needed in large sizes of sheet, bar stock, and tubing. As yet none has been produced in such sizes.

It's very possible, according to Dr. Kaufmann, that no single material will be found having all desired properties. Successful solutions to the problems may, therefore, lie in the development of composite materials. Composites could take the form of a combination where one material provides a protective surface layer against corrosion while the underbody supplies necessary strength. Or they could take the form of a collection of materials where one is effective in one temperature range, another effective in a different temperature range. Materials of this type can be constructed by mixing metals and refractory compounds. Such substances are known as cermets. Composite materials containing high-melting oxides will be useful from 2,000 to 4,000 F. For still higher temperatures, it will be necessary to use carbides and borides in conjunction with high-melting metals.

Probably graphite will become an important structural material for very high temperature use. It lacks strength and ductility at low temperatures, but becomes increasingly attractive at temperatures above 3,000 F. With techniques for protecting it from oxidation at high temperatures, it should find widespread application, particularly in a structure where some other material can supply necessary engineering properties at low temperatures.

Large Columbium Ingots Now Possible

Weighing in at 330 lb., the ingot shown above has proved it's possible to produce columbium ingots on a commercial scale (9-in. dia. by 19-in. long).

Made in roundels first by Electro Metallurgical Co. (div. Union Carbide), Universal Cyclops Steel Corp. melted the material via a consumable-arc process into ingot form.

Columbium, of course, is an up-and-coming material of construction. It has excellent high-temperature strength and a low nuclear cross-section.

High-Temperature Ti-Alloy Developed

New titanium alloys are coming up thick and fast (see *Chem. Eng.*, Aug. 11, 1958, p. 162 and Nov. 3, 1958, p. 152). Latest entry is Mallory-Sharon's MST 881, which has high-temperature strengths exceeding most steels.

The best current titanium alloys quickly lose strength when held for long periods above 800 F. But, according to Mallory-Sharon, MST 881 holds its strength after long exposures to 1,100 F. and for short periods at 1,500 F.

Primary markets for the new alloy will be in engines and components of manned and guided aircraft and missiles (taking advantage of titanium's excellent strength/weight ratio).

Alloy MST 881 contains 8% aluminum, 8% zirconium, 1% tantalum and columbium.

The material will be available as forging stock. Techniques for production of sheet materials are under investigation.

SOLVENT PACKINGS

"We tested one packing after another... but only 'U.S.' could stand up,"

Says CHEMICAL PLANT SUPERINTENDENT

When a leading mid-western chemical company put their new plant into operation in 1955, they faced a problem with pump packings: To find a packing resistant to a combination of solvents, caustic and high temperature—with a minimum of shaft wear.

"We tested one packing after another on our caustic pumps," says the plant superintendent, "and found that U. S. Solvent Packing outlasted any other packing tested *by as much as 10 to 1.*"

Result: No more morale-breaking "clean-up" sessions, production is increased, personal injuries due to leaks have been reduced 75%, and there's no need for rescheduling due to breakdowns.

A "U. S." technician, of course, worked with engineers of the chemical company to develop the right packing for this particular requirement. That's part of the "U. S." service, when needed.

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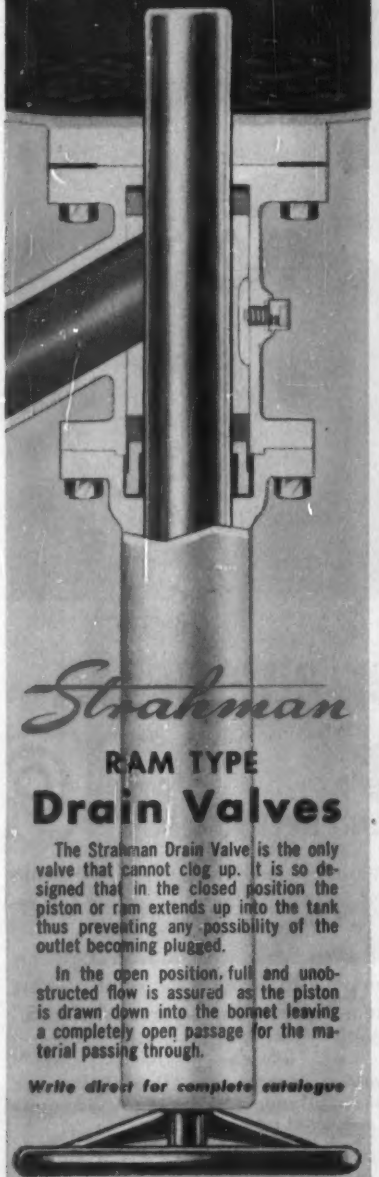

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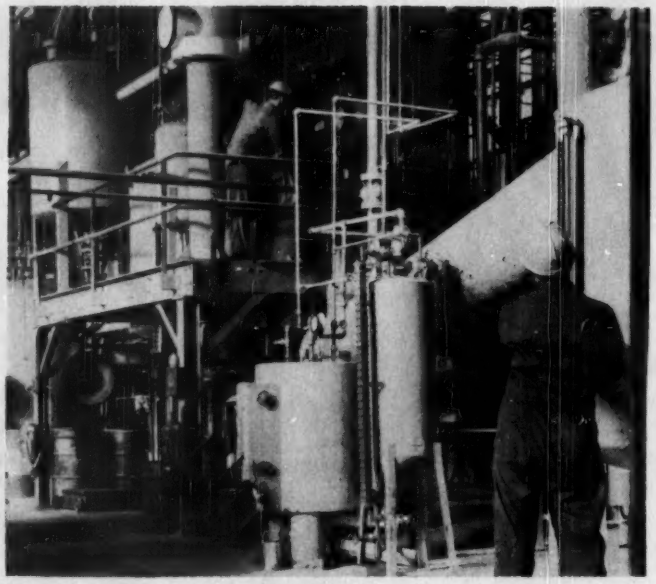

Expansion Mirrors Rising Use of Metal Hydrides

Recently doubled capacity at Metal Hydrides' Beverly, Mass., lithium-aluminum hydride plant reflects a rising demand for this inorganic in hormone synthesis, vitamins and other pharmaceutical preparations. MHI is exclusive manufacturer of Li-Al hydride, looks for new applications in fuels, catalysts and inorganic reducing agents.

International Nickel Co. is speeding construction on its new nickel mine and mill in the Sudbury District of western Canada. When completed in 1960, annual mill capacity will be 75 million lb. nickel, bringing Inco's total Sudbury output to 385 million lb./yr.

Air Products, Allentown, Pa., is building a unique argon purification system for an exotic-alloy fabrication facility being built at Bridgeville, Pa. Alloys of metals like columbium, molybdenum and rhenium will be worked in a room filled with pure argon; atmosphere will be recirculated every 3 hours through a −300 F. purification system. Universal-Cyclops Steel Corp. is constructing fabrication facility for U. S. Navy.

Fremont Minerals' new million-dollar sulfuric acid plant at Riverton, Wyo., is about to go on stream. With minimum capacity of 125 tons/day, plant can supply acid needs of all central Wyoming uranium mills. Plant was built by Leonard Construction Co.

Monsanto plans to make Mersize, a fortified rosin size used by paper manufacturers, in a new plant at Seattle, Wash., supplementing existing plant at Baxley, Ga. Unit is expected to be in operation in early 1959.

Du Pont's new titanium dioxide plant at New Johnsonville, Tenn., is slated to begin operation in January. Total

plant investment will run to more than $30 million; buildings will cover 115 acres and employ 425 workers initially.

Magnolia Petroleum plans to convert the Thermofor catalytic reforming unit at its Beaumont, Tex., refinery to a Sovaformer. (Sovaforming is a fixed-bed reforming process licensed from Socony Mobil.) Magnolia already has one Sovaformer at Beaumont; conversion of the Thermoformer will take about 18 months.

W. R. Grace has dedicated its new $5-million research center at Clarksville, Md. Bringing together 250 scientists and technicians formerly spread over three states, new center will be Grace's "hub of world-wide research and development activities."

Electric Reduction Co. of Canada claims to be world's largest producer of sodium chlorate as result of expansion that doubled capacity of firm's Buckingham, Que., plant. Sodium chlorate is used in uranium extraction and wood pulp bleaching.

Morton Chemical Co., subsidiary of Morton Salt Co., is ready to open a new adsorbent clay plant at Weeks, La., when construction is completed later this month. M. W. Kellogg handled erection of the plant.

Northern Chemical Industries announces that it has hired Chemetron Corp.'s Chemical Div. to operate its new ammonia plant and related facilities at Searsport, Me., under five-year lease. Plant, rated at 125 tons/day ammonia and 60 tons/day nitric acid, is one of first in U. S. to make synthesis hydrogen from Bunker C oil under Texaco-Hydrocarbon license.

Food Machinery & Chemical's International Div. has expanded hydrogen peroxide capacity of its Mexican affiliate, Electro Quimica Mexicana, to 4.5 million lb./yr. Increased demand for 50% solutions of H_2O_2 by Mexico's

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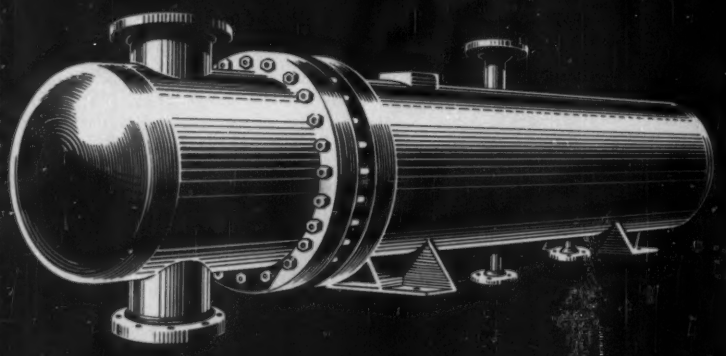

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cotton textile industry triggered the expansion.

Badger Mfg. Co.'s Dutch subsidiary, Badger - Comprimo N. V., has started construction on Esso Nederland's new $50-million refinery in Rotterdam. When completed in 1960, capacity will be in neighborhood of 95,000 bbl./day crude.

Fluor Corp. of Canada has been awarded two contracts totaling $1 million by Alaska-Yukon Refiners & Distributors. First contract calls for erection of a 3,000-bbl./day separation and treating plant at Haines Junction in the Yukon Territory. Second covers engineering and construction of a marine terminal at Valdez, Alaska.

Stauffer's Anderson Chemical Div. is expanding its manufacturing and laboratory facilities at Weston, Mich. Project, to be handled by Stauffer engineers, will cost about $220,000. Among Anderson's products are a broad range of metallo-organics.

Britain is planning world's largest nuclear power station: 650 megawatt capacity. Plant, 50 mw. bigger than stations Russians plan for Siberia, is destined for a site on the Suffolk coast in East England.

American Cyanamid's Formica Corp. has opened a new $5.5-million flakeboard plant at Farmville, N. C., capable of producing 40 million sq. ft. a year. Process uses green pine timber instead of the usual wood paste that goes into most particle board.

Diamond Alkali is building a new campus-style research center on an 800-acre tract near Painesville, Ohio. First two units of the multimillion-dollar center will be central research and development buildings. Construction plans are projected through 1970 so that the center can grow along with company activities.

Oak Ridge National Laboratory, operated by Union Carbide, will undergo a $9.6-million expansion, the Atomic Energy Commission announces. Plans include "major additions" to two buildings; Oak Ridge is free world's principal producer of radioisotopes for research.

Montecatini, Italian chemical maker, evidently has big plans in mind for its Moplen polypropylene: Stockholders have just approved a $48-million public bond issue for "petrochemical expansion." Topping the list of plans are new and expanded plants for polypropylene and other olefinic polymers. Moplen plant at Ferrara is already being expanded to 20,000 tons/yr.

Fisher Scientific Co., citing the change from wet-testing in laboratories to dry, instrument testing, has opened its new laboratory instrument manufacturing plant in Indiana, Pa. Products range from optical-electronic instrumentation to atomic-structure models.

Enjay Co. is adding a 30,000-sq.-ft. wing to its customer service laboratory at Linden, N. J., for plastics research. New wing will be devoted to Escon, Enjay's new polypropylene, that will be produced by Humble Oil (*Chem. Eng.*, Sept. 22, 1958, p. 191).

Coast Instruments, Long Beach, Calif., has opened a new optical plant to produce optical equipment for industrial applications and reflecting mirrors for telescopes.

Hagan Chemicals & Controls' new headquarters and research center is situated 12 mi. from downtown Pittsburgh, Pa. Center consists of a 60,000-sq.-ft. office building and a 33,000-sq.-ft. research laboratory.

Parke, Davis & Co. has dedicated its new $765,000 branch office in Menlo Park, Calif. Facility is headquarters for all northern California operations.

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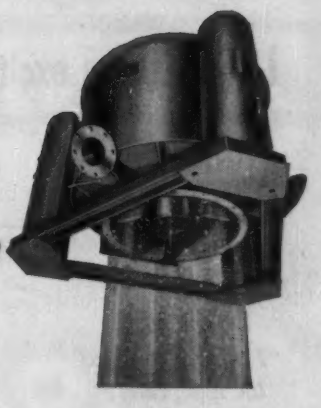

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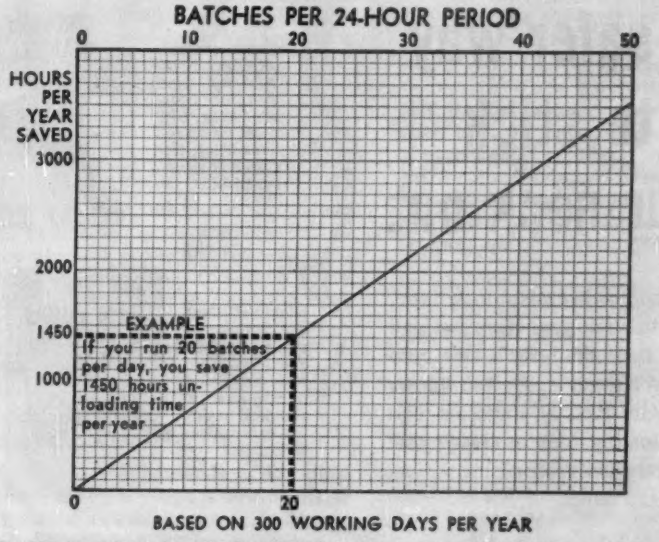

FOR MORE COMPLETE DATA, SEE TOLHURST'S SECTION IN CHEMICAL ENGINEERING CATALOG or write

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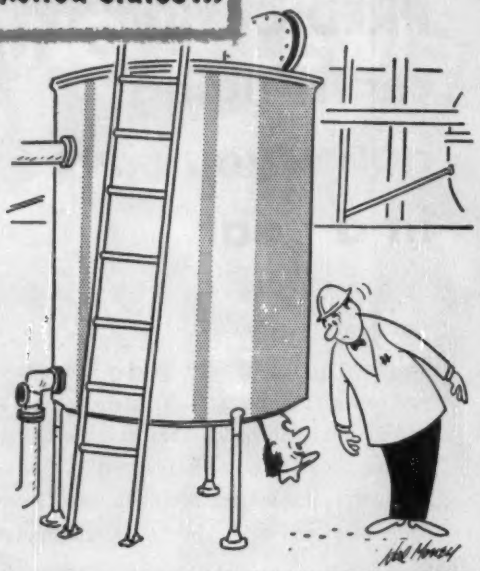

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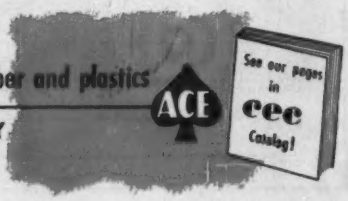


FIRMS . . .

NEW LOCATIONS

Girdler Catalysts is establishing a New York sales office at 79 Wall St. Girdler makes specialty catalysts for chemical, petroleum and gas processes.

International Paper Co.'s market research and product development operations have been shifted from Camden, Ark., to firm's New York City headquarters.

B-I-F Industries, Providence, R. I., is relocating its Berkeley office to 1766 Locust St., Walnut Creek, Calif. Office handles firm's line of meters, feeders and controls.

Hooker's Phosphorous Div. executive sales office has been moved to the Lincoln Building, 60 E. 42nd St., New York 17, N. Y., locating it next to Hooker's other New York offices.

MERGERS & ACQUISITIONS

Vick Chemical Co. has acquired its first overseas drug company: Milton Antiseptic, Ltd., London. This is Vick's third acquisition in the past three months, other two being the Lavoris Co. and Walker Laboratories.

Dallas Tank Co. and Trinity Steel Co., two large steel fabricating firms, have merged. New firm will continue under the Trinity Steel Co. name and offices and facilities will move to 4001 Irving Blvd., Dallas, Tex.

American Petrofina is acquiring the assets of Reco Oil Co. for an undisclosed amount. Included in the transaction are Reco's interest in 111 producing wells.

Pittsburgh Plate Glass, in an exchange of shares, has acquired all assets of Barium Reduction Corp., South Charleston, W. Va. Barium Reduction, maker of barium chemicals, related byproducts and carbon bisulfide, will be operated by Columbia-Southern Chemical Corp., subsidiary of Pittsburgh Plate.

Badger Mfg. Co. has become sole owner of its Dutch affiliate, Badger-Comprimo, N. V., by acquiring the 50% interest held by Comprimo of Amsterdam. Badger-Comprimo offers engineering, procurement and construction services to European petroleum, chemical, pharmaceutical and nuclear industries.

NEW LINES

Houdry Process Corp. now offers a new spherical mineral Kaolin cracking catalyst, claimed to decrease catalyst consumption and equipment maintenance because of its spherical form.

Koppers' Metal Products Div. and the Belfab Corp. have signed an agreement allowing Koppers to use Belfab's design and manufacturing know-how in making bellows. Metallic bellows convert changes in pressure and temperature into mechanical motion.

NEW REPRESENTATIVES

Dow Chemical has appointed J. T. Baker Chemical Co. to handle its Dowex ion exchange resins in laboratory and research quantities. Resins will be marketed as "Baker Analyzed" reagents.

PLASTIC PIPE AD WITH NO PICTURE?

Why no picture: Because almost all plastic pipe looks the same. You know yourself that looks can be mighty deceiving, and piping that goes wrong can be mighty expensive. A picture means nothing... but...

There are scores of brands of plastic pipe on the market... made of a dozen different kinds of materials. Most of it is labeled "corrosion-resistant" but the results may be good, bad or indifferent depending on your choice. A picture is no help. Here's what to look for instead:

The universal material? No such thing. No one plastic can handle all liquids and gases... no one has *all* the physical properties required of a truly universal pipe. Closest to it are Ace Riviclor (Rigid PVC) and Ace-Ite (rubber-plastic blend). The former is a little better on chemical resistance, the latter is a little better on impact strength and heat resistance. Both same price.

Are plastics strong enough? Thousands of chemical plants say "yes". Pipe is now available in several wall thicknesses... in flexible tube sizes (Ace-Flex clear transparent), up through gas-tubing sizes (Ace-Ite and Ace Riviclor), through flexible Supplex polyethylene pipe, and Schedules 40 and 80 rigid plastic pipe for pressures up to 490 psi.

Above that, there's Ace rubber-lined steel pipe. And don't forget Ace soft-rubber-lined pipe for resistance to abrasion.

Where do I use it? For corrosive chemicals and gases of all types. The only ones that are difficult are certain solvents and chlorinated aromatic hydrocarbons, and if you're careful to pick the right *one* of the *many* Ace materials, you can even handle most of these tough corrosives. Use plastics, too, for water lines, gas lines, electrical conduit, etc., or any lines where the pipe passes through corrosive vapors or damp areas, or goes underground.

Is there a plastic for hot corrosives? Yes, Ace Tempron, which is good to 275 deg. F. with most chemicals. Stays chemical resistant, strong, and rigid where other plastics may be attacked or may sag.

How can I dodge "trial and error"? Go to a company that has no axe to grind. We, for instance, make no less than nine different kinds of pipe ... with fittings and valves to match... and give you thoroughly unbiased advice backed by 100 years of experience and prices as low as you'll find anywhere.

FREE SELECTOR CHARTS

20 valuable pages... comparable properties, chemical resistance, costs, etc. of 11 plastics and rubber materials Write today for Bulletin CE-50.

AMERICAN HARD RUBBER COMPANY
Division of Amerace Corporation
ACE ROAD · BUTLER, NEW JERSEY

This man, cleaning a tank-truck interior of alkyd resin deposits, accomplishes

Oakite Interior Tank Cleaning Unit, Model 531. Automatically sprays hot cleaning solution under pressure. Nozzles rotate vertically and horizontally. Rinses after cleaning. Sprays 45 gal/min at 150 lbs. pressure.

18 hours cleaning in 1 hour

At a New England chemical plant, it used to take three men working six hours to clean out each truck tank—two men inside the tank scrubbing, scraping and sloshing, one man astride the dome to watch in case the oxygen tanks gave out. Even at that, a careful inspection was needed to make sure the tank was properly clean.

That's how it *was*. Now, one man equipped with the Oakite 531 Interior Tank Cleaning Unit, using a cleaning solution recommended by the local Oakite representative, does the whole job in one hour flat. A sweet job, too, with the tank interior shining like new.

It's just one of the many ways Oakite methods and materials save time and money in chemical plants . . . and why you may find it well worth your while to call in your local Oakite man. Meanwhile, for details about Oakite tank cleaning equipment and Oakite cleaning methods for the chemical industry, write to Oakite Products, Inc., 16H Rector Street, New York 6, N. Y.

Technical Service Representatives in Principal Cities of U. S. and Canada

Export Division Cable Address: Oakite

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE
SCIENCE

In our 50th year.

CALENDAR

Spectroscopy Society of Pittsburgh, monthly meeting, Mellon Institute of Industrial Research.
Dec. 17 Pittsburgh, Pa.

The Physical Society, Conference on Solid State Physics, Lowther Gardens.
Dec. 18-19 Cambridge, England

American Assn. for the Advancement of Science, annual meeting, Hotel Statler.
Dec. 29-30 Washington, D. C.

American Institute of Chemical Engineers, North Jersey Section, Topic: Oil and Chemicals from Sasol Process, Shulton Lab.
Jan. 6 Clifton, N. J.

American Society for Engineering Education, Cooperative Education Midwinter Meeting, Del Prado Hotel.
Jan 8-9 Chicago, Ill.

Lehigh Valley Chemical Engineers Club, Topic: Process Instrumentation, Lehigh University.
Jan. 19 Bethlehem, Pa.

Spectroscopy Society of Pittsburgh, monthly meeting, Mellon Institute of Industrial Research.
Jan. 21 Pittsburgh, Pa.

American Society of Lubrication Engineers, Symposium: Lubricants for Gears, Morrison Hotel.
Jan. 25-27 Chicago, Ill.

American Society for Engineering Education, Mid-winter meeting, University of Houston.
Jan. 26-27 Houston, Texas

Plant Maintenance & Engineering Show, Public Auditorium.
Jan. 26-29 New York, N. Y.

Canadian Pulp and Paper Assn., Technical Division, annual meeting, Queen Elizabeth Hotel.
Jan. 26-30 Montreal, P. Q.

Society of Plastic Engineers, annual technical conference, Commodore Hotel.
Jan. 27-30 New York, N. Y.

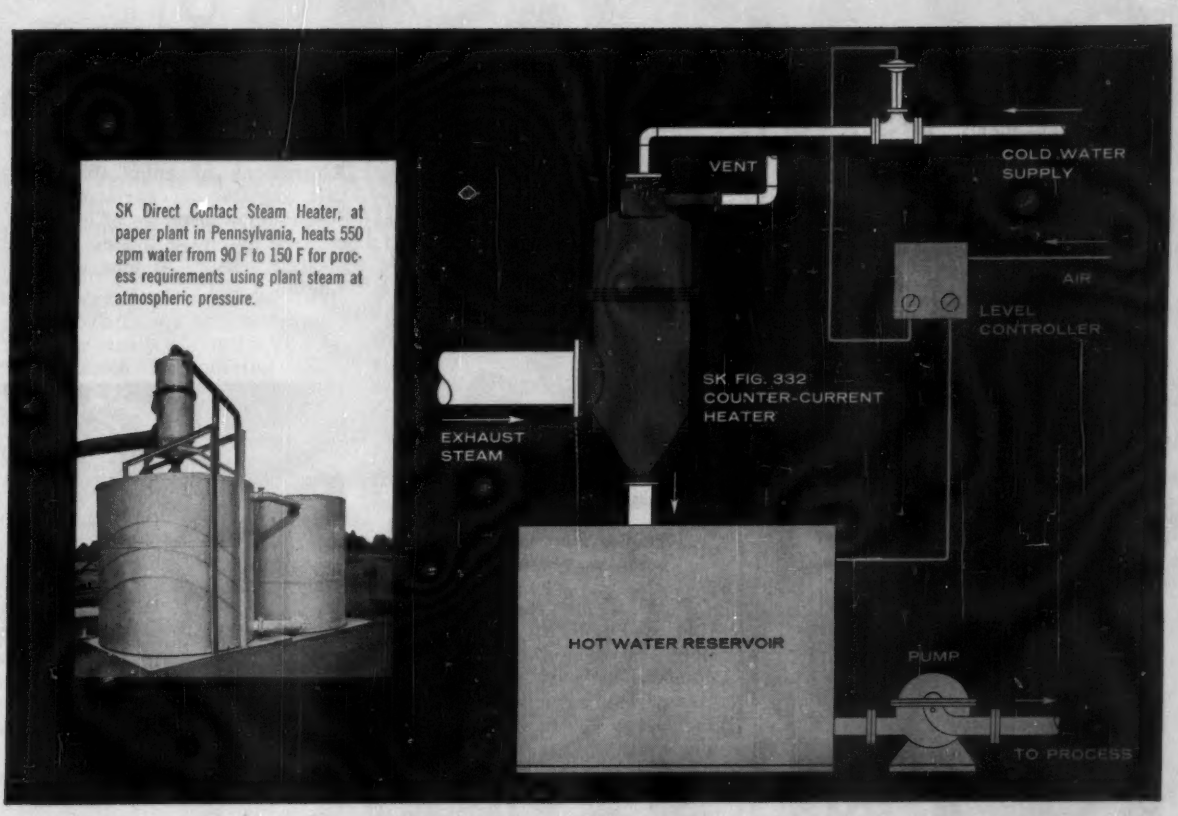
First International Symposium on Nuclear Fuel Elements, jointly sponsored by Columbia University and Sylvania-Corning Nuclear Corp., Columbia University.
Jan. 28-29 New York, N. Y.

American Physical Society, annual meeting, New Yorker Hotel.
Jan. 28-31 New York, N. Y.

Society of Plastics Industry, Reinforced Plastics Division, annual technical and management conference, Edgewater Beach Hotel.
Feb. 3-5 Chicago, Ill.

American Institute of Mechanical Engineers, annual meeting, St. Francis Hotel, Sheraton-Palace Hotel, and Sir Francis Drake Hotel.
Feb. 15-19 San Francisco, Calif.

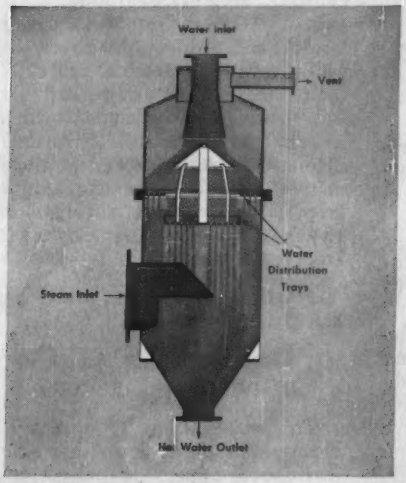
Lehigh Valley Chemical Engineers Club, Topic: Radioactive Tracers in Process Control, Lehigh University.
Feb. 16 Bethlehem, Pa.


SK Direct Contact Steam Heater, at paper plant in Pennsylvania, heats 550 gpm water from 90 F to 150 F for process requirements using plant steam at atmospheric pressure.
VENT
COLD WATER SUPPLY
AIR
LEVEL CONTROLLER
SK FIG. 332 COUNTER-CURRENT HEATER
EXHAUST STEAM
HOT WATER RESERVOIR
PUMP
TO PROCESS

FOR HOT WATER IN LARGE QUANTITIES

use SK Direct Contact Steam Heaters

Sectional drawing of SK Fig. 332
Direct Contact, High Capacity, Steam Heater



SK Direct Contact Steam Heaters are designed to provide large quantities of hot water, or other liquid, for plant or process use. They do this by using plant exhaust steam (at low pressure or at vacuum to 15 in. Hg) to heat the water which is then delivered to a tank or reservoir.

To users, these high capacity heaters offer specific, worthwhile advantages. They are simple in design, have no moving parts. Heating, by condensation of steam in the liquid, is very efficient, continuous, and fast. A temperature rise of 130 F is possible with most of these units. Semi-solids in the liquid are handled without difficulty. Costs are reasonable and the heaters require little maintenance. Capacity can be just about any reasonable amount desired, since capacity is determined by heater size and SK has not established any maximum. Although cast iron and fabricated steel are standard materials of construction, other special materials can be used when required.

The counter-current unit pictured above and at left is one of four types made by SK. This particular heater and all of the other types are described in detail in Bulletin 3A-HC which includes application information and data on sizes, dimensions, and capacities. Copies of Bulletin 3A-HC are available immediately on request. Send for a copy.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin 17-A.

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2217 State Road, Cornwells Heights, Bucks County, Pa.

For Chemical Process Industries

LUZERNE

CHECK LIST

Of Complete Corrosion-Resistant Materials, Equipment and Services

PVC & OTHER CUSTOM MOLDED PLASTICS

Specializing in intricate, heavy parts; metal inserts molded in.

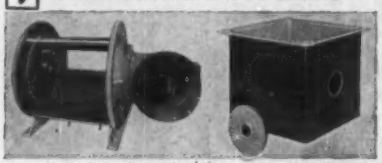
HARD RUBBER, CUSTOM MOLDED

New uses, new compounds of this reliable chemical-resistant material.

PVC FABRICATIONS & ROLL COVERING

Unlimited applications and versatility for this fine plastic—rigid polyvinyl chloride.

HARD RUBBER & PVC LINING



Complicated castings, also pipe, fittings and tanks lined to specification.

HARD RUBBER PUMPS

New mechanical seal eliminates usual packing troubles.

PVC & HARD RUBBER PIPE, FITTINGS & VALVES

PVC sizes ¼" to 12", temperature to 140° F. Hard rubber sizes ¼" to 8", temperature to 225° F. in heat-resistant Buna-N.

Write for complete information or contact our sales representative nearest you.

For ready reference look us up in Chemical Engineering Catalog

The LUZERNE RUBBER CO.

100 Muirhead Avenue Trenton, N. J.

Sales Representatives

ALBERT J. COX CO. Chicago, Ill.

R. C. FOLTZ CO. Houston, Texas

(*Continued from p.* 96)

Pneumatic Conveyor

Trailer-mounted system is portable, compact.

Part of the manufacturer's line of Pneu-Pac equipment, a new trailer-mounted, portable, combination positive- and negative-pressure pneumatic system is claimed to be ideal for in-plant handling of granular free-flowing materials. Conveying capacity varies with size and density characteristics of the material being handled, and also with the combined vertical and horizontal travel distance.

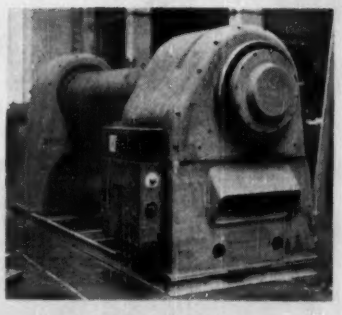
Over-all height of the system is less than 8 ft. In spite of its compact size, the unit includes a 14 × 10 rotary-vane airlock feeder and an in-line filter with removable filter bag.—**Sprout, Waldron & Co., Muncy, Pa. 208A**

Color Controller

May find application in process industries.

One typical application of a new monitoring system is automatic control of processes in which materials color is of critical importance. Known as Optical Automatic Ranging (OAR), the system quickly and exactly responds to minute color variations with corrective motions applied by a servo-motor system. Such motions would restore predetermined color values without interruption of product flow.

OAR is also claimed to be useful for measurement and control of high temperatures at conditions unsuited for thermometric devices. Operation in either application depends on observation of product color through a simple lens system. Alterations of color distribution register as variations in frequency and phase of current emitted by an oscillating photoelectric sensor.—**Compaco, Inc., Encino, Calif. 208B**



Pulp Filter

German manufacturer now testing new unit.

Still in the prototype stage, a new German-made, horizontal-cylinder filter may eventually find wide application for removal of large quantities of solid matter from pulps. Since the unit is yet undergoing preliminary checkout tests, no capacity figures are available.

Briefly, operation is as follows: Feed pulp enters the annular space between a central cylindrical screen and a revolving outer casing equipped with internal worm threads. Filtrate discharges from one end of the central tube; solid matter exits from the rotating casing.—**Eberhard Hoesch & Soehne, Dueren, Germany. 208C**

Paging System

Alerts personnel to pick up nearest phone.

To reach key personnel throughout plant areas, a PBX switchboard operator dials their respective numbers on the dial of the new Personal Page system. A radio transmitter sends the call numbers to the receiver sets carried by personnel being sought. Upon stimulation by the proper signal, these receivers emit an audible sound, alerting the wearers that they are

being paged, and to pick up the nearest telephone.

Each system will handle selective paging of an unlimited number of people within or near plant premises. Unaffected by shock or vibration, the miniature transistorized receivers are completely self-contained, including batteries and antenna. Receiver size is about 6 x 2½ x ½ in. — **Hanak Engineering Co., Bala-Cynwyd, Pa.** 208D

Specialty Filters

For industrial use under harsh conditions.

Using specially formed ribbon-type metal, porous metal fibers and powders, synthetics and absorbent materials, the manufacturer has developed a completely new line of industrial filters. Typical applications for the new line include removal of CO_2 from liquid oxygen, contaminants from molten sodium, and capture of entrained dust leaving fluidized beds.

Metal-edge filters, made by spiraling trapezoidal ribbons of wire into cylindrical form, and welding in place, are useful for fine filtration of liquids. Such filters can be made to remove particles as small as 0.3 microns at temperatures ranging from —420 to 1,500 F. and pressures to 10,000 psi.

Porous metal filters, which can be constructed of media such as gold, Monel or tantalum, are useful for filtration of highly corrosive gases. Since these filters can have convoluted shapes, they are also applicable in situations where a high filtration area must be crammed into a small volume.— **Purolator Products, Inc., Rahway, N. J.** 209A

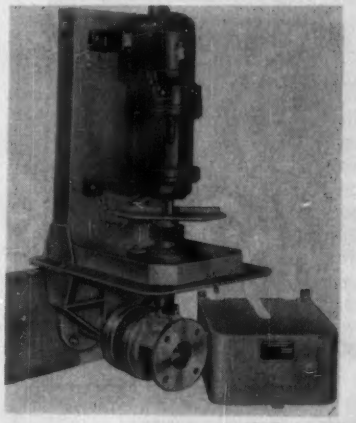
Silicon Rectifier

Short circuit does not disrupt operation.

Available in ratings of 1,000-10,000 amp. at voltages to 300 v., GE's new water-cooled silicon rectifier provides either regulated or unregulated d.c. power. Manual or automatic regulation via a saturable reactor-amplistat system gives smooth, stepless control from 10 to 125% current output. Unit efficiencies range from 90-95%.

A leading feature of the saturable reactor is that it restricts short-circuit current to a value about 20% greater than the current prior to the short circuit. The rectifier will withstand such an output without damage to components.

Designed to provide rapid fault isolation, the unit's control panel is equipped to indicate such abnormal conditions as water flow failure; power fuse; and transformer, cooling water or reactor over-temperatures. — **General Electric Co., Schenectady, N. Y.** 209B



Motor-Driven Valve

Closes automatically if power fails.

A new motor-driven ball valve for remote control of liquid flow is now available for 3- and 4-in. piping. Claimed to be practically maintenance-free, the valve has a full-round port area that keeps stream turbulence and resulting friction to a minimum. The electric torque-type motor operates to a stall in both open and closed positions —thus, no limit switches are required. And, a fail-safe mechanism immediately closes the valve in event of power failure.

Standard materials of construction include chrome-plated bronze for the ball and resilient synthetic rubber for the seat.

HIGH EFFICIENCY

DUCLONES®

assure maximum recovery at lowest cost

DUCLONES—Ducon high efficiency cyclones—are designed and constructed for high recovery efficiency and low gas resistance. Their sturdy construction assures long, continuous service with a minimum of maintenance.

The exceptional performance of Duclone collectors is the result of these 6 unique features:

1. **Small Diameter produces high efficiency**
2. **Helical Roof provides a turbulence-free path for the entering gas stream**
3. **Steep Cone improves dust separation**
4. **Dust Trap assures efficient dust removal from the cone**
5. **Vortex Shield prevents re-entrainment of dust in upward gas vortex**
6. **Scroll Outlet provides a low resistance clean gas outlet**

send for Bulletin C-958.

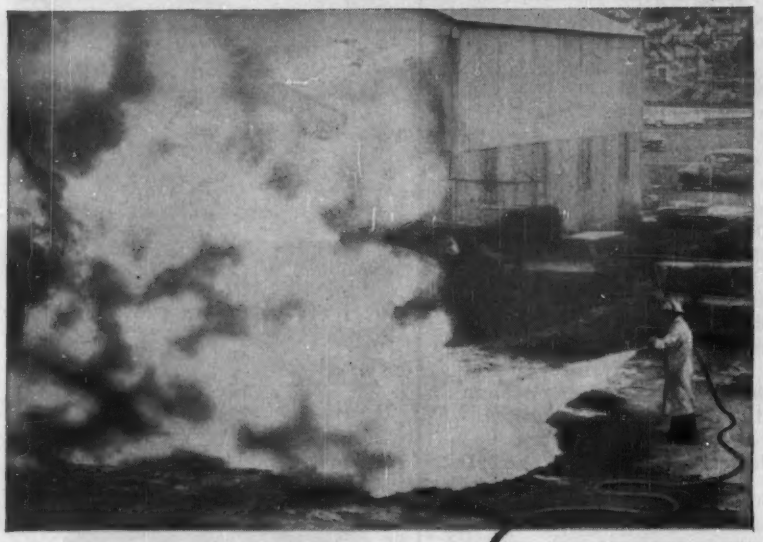
DUCON — DUST CONTROL SYSTEMS AND EQUIPMENT

the name in DUst CONtrol

THE **Ducon** COMPANY Inc.

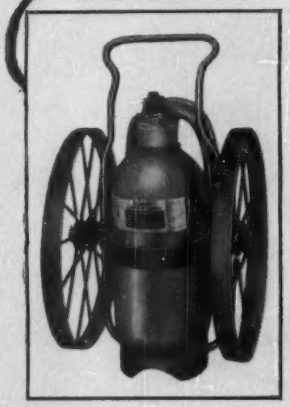
147 EAST SECOND STREET • MINEOLA, L. I., NEW YORK

NEW! FOR FIGHTING CHEMICAL FIRES!



ONE-MAN DRY CHEMICAL KILLS MORE FIRE FASTER!

This new Kidde 200-pound pressurized unit has an *extra* 50 pounds of fire-smothering dry chemical, is designed for faster, easier operation. Its 40-foot stream gives more efficient extinguishing action, greater heat protection for the operator! No valves to unscrew, no wait for pressure, no pressure reducer to cause you trouble. Just remove safety pin, flip valve toggle, turn on nozzle lever. No conventional seal. Its exclusive Bridgeman seal holds pressure by using 450 psi to exert a *three-ton* sealing force.



COMPLETELY NEW DRY CHEMICAL LINE GIVES FASTER, EASIER OPERATION!

On the left, the new Kidde 20-pound dry chemical portable — completely new, completely better. The simplest, most efficient dry chemical portable on the market. Features include oversize aluminum handle for gloved-hand operation, perfect balance for faster action, simple one-two operation. Remove horn, pull trigger, and fire's out. Rugged, dustproof pressure gauge is recessed for protection. 10, 20- and 30-pound Kidde portables pressurized at 225-250 psi. Coming soon—new 2½- and 5-lb. models charged at 140-160 psi. Write today for information about this new Kidde line!

Kidde

Walter Kidde & Company, Inc.
1228A Main St., Belleville 9, N.J.
Walter Kidde & Company of Canada Ltd.
Montreal—Toronto—Vancouver

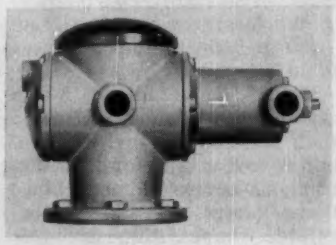
The unit also comes in stainless steel for corrosive applications. —Gemco Inc., Cleveland, Ohio. 209C

Mass Flow Transducer

Instrument for gases has no moving parts.

Qualified for service in passenger-carrying commerical jet aircraft, a new mass flow transducer may also find considerable application in the process industries. Having no moving parts, the device puts out 100-microampere signals that are dependent on true mass flow, and are independent of gas temperature and pressure. Range is equivalent to 20-80 lb./min. of air flowing in a 6-in. duct.

Each transducer consists of two platinum resistance probes that form the active elements in opposite arms of a d.c. resistance bridge. Both probes extend into the flow stream. The upper, heated probe makes the fundamental density-velocity measurement as it is cooled by gas flow. The unheated, lower probe compensates for gas temperature. — Trans-Sonics, Inc., Burlington, Mass. 210A



Valve Positioner

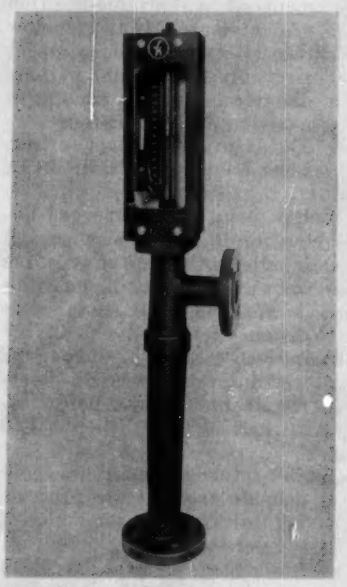
Features high versatility and premium performance.

A top-mounted integral positioner, known as the Model J, combines a force-balance design with a pilot-operated relay valve. According to the manufacturer, the new unit provides high power output, and matches or exceeds the speed and sensitivity of modern pneumatic controllers.

Model J is suitable for use on both cylinder- and diaphragm-type actuators.

Maximum stroke length is 8 in.; regardless of stroke length, linearity is better than 1%. Unaffected by vibration, Model J positioners respond to signal changes as low as 0.001 psi. And, reproducibility is claimed to be 0.1% of full travel.

Each new positioner is suitable for use in the most adverse weather conditions and plant atmospheres—an anodized aluminum housing protects all moving parts.—**Conoflow Corp., Philadelphia, Po.** 210B



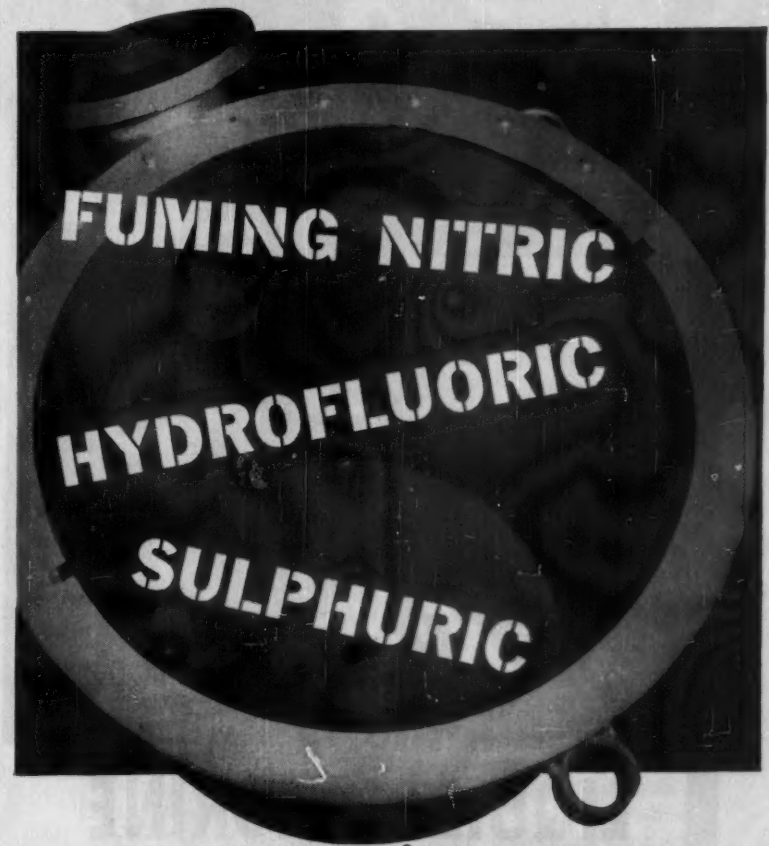
Rotameter

Measures flow of hard-to-handle fluids.

Rugged design of a new line of rotameters makes it suitable for service with hazardous and high-pressure fluids at temperatures up to 400 F. All fluid-contacting parts are stocked in stainless steel; if desired, they are also available in carbon steel, Hastelloy or special alloys. Rotameter capacity ranges from 0.24-2.4 gpm. for the smallest model to 10-100 gpm. for the largest.

Fluid enters the bottom of a metal tube, flows upward, and exits through the flanged side opening. With increase of flow, the metering float rises, thus causing change of position of a magnet fastened to the float's

UP AGAINST THE WORST?



only CHEMISEAL® Fluorocarbon Plastic LININGS will do

Certified Applicators:

Atlas Metal Protection, Inc. Houston, Texas
The Barber-Webb Company, Inc. Los Angeles, Cal.
Belke Mfg. Co., Inc., Chicago, Ill.
Buckley Iron Works, Dorchester, Mass.
Electro-Chemical Engrg. & Mfg. Co. Emmaus, Pa.
Metalweld, Inc., Philadelphia, Pa.

Chemiseal Linings are impervious to *all* the most difficult acids, alkalies and other highly corrosive chemicals. They permit you to handle such chemicals with ordinary plant equipment.

In addition, they withstand temperatures from —320° F. to +250° F. Have high impact strength. Are tough—not brittle. Are readily cemented over any contour and to any material of equipment construction. Seams are heat-sealed into a continuous, chemically-inert surface.

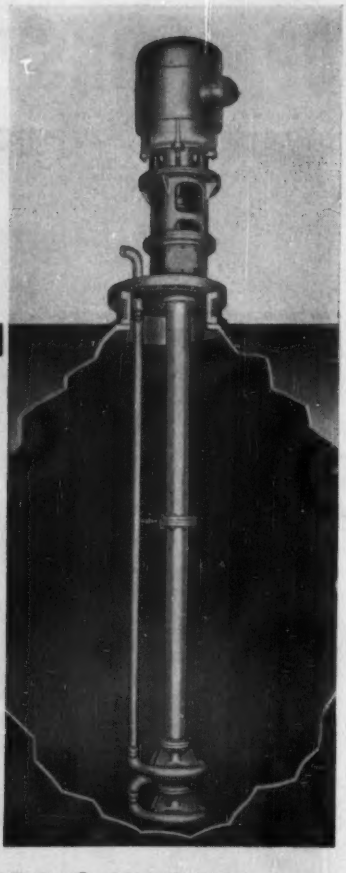
Chemiseal Fluorocarbon Plastic Linings are available through certified applicators (listed at left), who are trained and equipped to insure best results.

Write for Bulletin AD-152.

Special Products Department
UNITED STATES GASKET COMPANY
Camden 1, New Jersey

USG United States Gasket

Plastics Division of **GARLOCK**



Lawrence 2-Stage Vertical Pump for Pumping Liquid Chlorine out of Tanks.

PUMPS to handle LIQUID CHLORINE

Pumping liquid chlorine calls for more ingenuity and engineering skill than is available from the average pump manufacturer. Formerly it was pumped pneumatically. This method was attended by a considerable loss of chlorine because the moisture in the air formed hydrochloric acid. A further complication was the corrosive action of the acid vapors.

To overcome this, Lawrence engineers in collaboration with manufacturers of chlorine, developed a pump with a special packing box which prevents any contamination of the chlorine or corrosion of any of the equipment and also prevents the escape of the chlorine fumes to the atmosphere.

For over 80 years Lawrence has been making pumps to handle every acid or chemical fluid used in industry. If you have a particularly difficult chemical pumping problem, we can save you both time and money. Write us the pertinent details, no obligation.

Send for Bulletin 203-7 for a complete summary of acid and chemical pump data.

LAWRENCE PUMPS

LAWRENCE PUMPS INC.

371 MARKET STREET, LAWRENCE, MASS.

extension rod. A follower outside the extension tube, which is magnetically coupled to the moving magnet inside, indicates flow rate.—**Schutte & Koerting Co., Instrument Div., Cornwells Heights, Pa.** 211A

BRIEFS

Miniature flow meters for ¼-in. piping come in a variety of models covering an over-all range of ¼ to 4 gpm. Movement of a variable-position orifice visually indicates flow rate. Because of its compact size, only 4⅞ in. long by 1⅛ in. diameter, the unit mounts in low-clearance locations. —**The Henry G. Dietz Co., Inc., Long Island City, N. Y.** 212A

Sump pump for submerged operation in wet-pit service will handle both fine and coarse slurries. Quick dismantling is possible—only four bolts clamp the liquid end. Nine models, varying in size from 2 to 8 in., are available.—**Morris Machine Works, Baldwinsville, N. Y.** 212B

Boiler return system routes condensate from steam processing units back to the boiler at temperatures only 15-20 F. lower than those at operating pressure. Unit is claimed to drop fuel costs 15-25% and makeup water needs by 90%. Manufacturer offers the system on a 60-day trial basis.—**Stickle Steam Specialties Co., Indianapolis, Ind.** 212C

Scintillation probe provides precision detection of fast or slow neutrons as well as gamma and beta radiation. Utilizing a new 10-stage, ¾-in. photomultiplier tube and a transistorized electronic circuit, the basic detector weighs less than 5 ounces.—**Nuclear-Chicago Corp., Chicago, Ill.** 212D

Hand truck for palletized loads of bagged materials features two-wheel brakes for safety of motion on inclines. Constructed from aluminum or steel tubing, the tilting truck

permits handling of loads as heavy as 1,000 lb. — **Valley Craft Products, Inc., Lake City, Minn.** 212E

Portable acid buggy, consisting of a rubber-lined steel tank, a 35-gpm. all-rubber centrifugal pump, and rubber hose, provides a safe and convenient means of moving acids around plant areas. Pump motor is ½ hp.—**Perma-Line, Chicago, Ill.** 213A

Plastic gate valves having socket weld ends are available in sizes from 1½ to 2 in. Plastic is either PVC or styrene copolymer. Each valve offers a combination of straight-through flow and close throttling control. — **Vanton Pump & Equipment Corp., Hillside, N. J.** 213B

Pressure gage with a solid, integrally cast metal front plate affords greater protection to workers in event of Bourdon tube rupture. Offered in 4½- and 6-in dial sizes, the gage measures pressures to 20,000 psi. with accuracies of ±½% of full scale. — **American Chain & Cable Co., Inc., Bridgeport, Conn.** 213C

Seals and gaskets made of Viton, a new broad-temperature-range polymer, have high resistance to deterioration by heat, oils, solvents and corrosive liquids. On dry test, Viton gave a good performance at 450 F. for 1,000 hr. — **The Garlock Packing Co., Palmyra, N. Y.** 213D

Greasing tool eliminates the need for replacing sealed ball bearings when the original packed-in grease gives out. Model A applies grease to units having 0.75-1.0625 in. I.D. and 1½-2 in. O.D. Model B is for 0.375-0.687 I.D., 0.75-1,625 O.D.—**P-G Corp., Chevy Chase, Md.** 213E

Strip chart planimeter integrates records produced on the manufacturer's 4-in wide recorders. Change of a characterized cam varies operation from linear to square root totalization. Integrating

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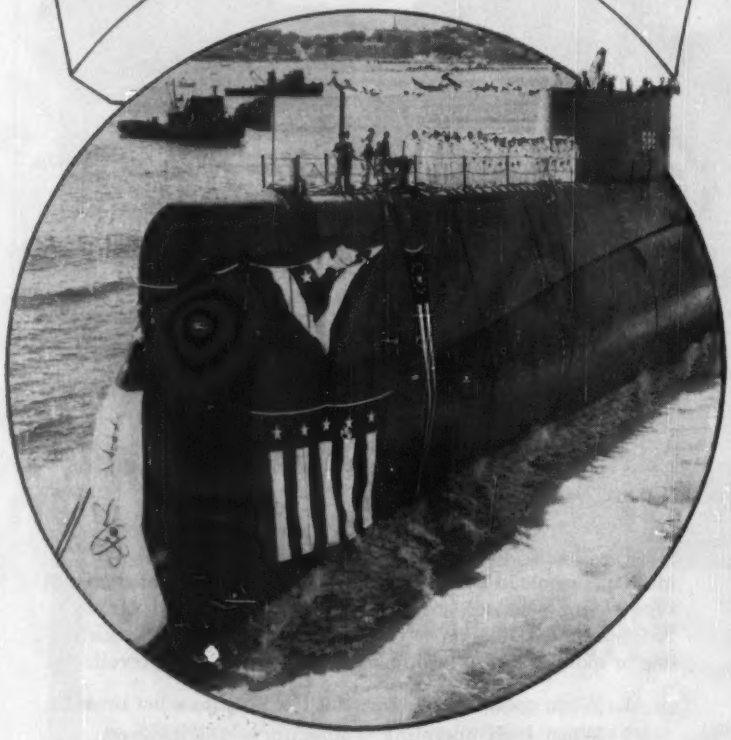

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rate is 0-12 chart hours per minute.—**Fischer & Porter Co., Hatboro, Pa.** 213F

Finned tubes in the manufacturer's line of heat exchangers now come in sizes up to 6 in. Tubes withstand pressures up to 5,000 psi. and temperatures to 1,150 F., depending on materials of construction. — **Griscom-Russell Co., Massilon, Ohio.** 214A

Flexible pipe made of polyethylene combines advantages of high resistance to stress-cracking with a chemical resistance comparable to PVC piping. Offered in sizes ranging from ½ to 8 in. dia., the pipe has a maximum working temperature of 150 F.—**Carlon Products Corp., Cleveland, Ohio.** 214B

Equipment Cost Indexes . . .

	June 1958	Sept. 1958
Industry		
Avg of all.....	230.7	230.9
Process Industries		
Cement mfg.	222.2	223.3
Chemical	231.7	232.3
Clay products	216.0	217.0
Glass mfg.	218.8	219.3
Paint mfg.	223.1	222.8
Paper mfg.	223.3	223.8
Petroleum ind.....	227.9	227.5
Rubber ind.....	230.7	230.3
Process ind. avg..	228.2	228.6
Related Industries		
Elec. power equip...	234.3	236.0
Mining, milling	233.1	233.7
Refrigerating	260.7	260.3
Steam power.....	218.4	218.1

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 125—6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143-4 for annual averages since 1913.

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p. 237)

TECHNICAL BOOKSHELF

J. B. BACON

"For Those Who Will Break With Tradition . . ."

PROCESS DYNAMICS; DYNAMIC BEHAVIOR OF THE PRODUCTION PROCESS.

By Donald P. Campbell. John Wiley & Sons, Inc., New York. 316 pp. $10.50.

The late Donald P. Campbell called this long-anticipated book a "primer" in the sense that it would offer first readings to the feedback control expert in a fundamental new field, a field which he called process physics.

This only partially describes this pioneering text. A more functional description might be that it is a "prime mover" which surely will overcome the inertia of both process and control engineers who neglect the implications of process dynamics in their work. For this is a book of exciting new ideas as well as compelling engineering—a combination that is bound to motivate as well as teach.

Campbell's contributions to fundamentals of engineering thought started with his first text, the now-famous "Principles of Servomechanisms," which he co-authored with Gordon S. Brown, his colleague at M.I.T., in 1948. This classic book introduced the powerful methodology of closed-loop control to the general engineering field. The potential for this methodology in the continuous-flow processing industries intrigued Campbell and in 1952 he started on the present book. His work was almost complete in January, 1957, when the gifted engineer-scientist suffered a heart attack and died at an untimely 38.

Fortunately, one of Campbell's close colleagues during these formulative years was Page S. Buckley of the Du Pont organization. We are greatly indebted to Buckley for the devoted job he did in readying the manuscript for the printer.

▶**A Mission**—The mission of the book, in words from the preface, is "to explain process physics and translate these basic definitions of process dynamic performace into mathematical form so that their influence upon process control system design can be shown."

In carrying out this mission the author presupposes two things: That the reader is familiar with the principles of automatic control theory, at least at the level of the Brown and Campbell text; that he is able to cope with both ordinary and partial differential equations and the Laplace transformation. However, while this definitely pitches the book at a rigorous level for student and working engineer, this reviewer believes that enough important and understandable nonmathematical new ideas are present to compel the interest and study time of many people who may not be so well prepared.

▶**A Thesis**—Don Campbell's thesis is that an engineer, in order to progress beyond the present state of the art in the design of processes (which is based on static or steady-state information), must set about determining the dynamic response of these processes and must proceed in writing the differential equations or developing the mathematical models which describe this behavior. He must systematically subject the cause-and-effect physical relationships to the logical disciplines of mathematics in order to synthesize new, more complete and fundamentally improved processes.

The book approaches the dynamic behavior and mathematics of processes in six basic chapters: Kinematics of Materials Handling; Fluids in Motion; Forming, Propulsion and Guidance; Thermal Process Dynamics; Mass Transfer Dynamics; Chemical Process Dynamics. In addition it includes ten pages of fascinating problems to demonstrate the application of dynamic analysis in each of these processing areas. It also includes sections which explain the use of block diagrams and summarize the theory of Fourier and Laplace transformations.

▶**Lucid Thought**—Each of the chapters in this book contain several introductory pages of lucid and often original analogistic thinking on the relationship between production-process behavior and established concepts from some of the fields of modern physics.

For example, the use of acoustic science and its equations is related to the transient behavior of fluid networks. Statistical mechanics are turned onto the difficult problems of mass transfer and chemical reaction kinetics. The significance of noise in flow processes is considered.

Exposure to the unelaborated concept of these techniques for process analysis alone would make this book extremely valuable. But each chapter then goes on into a solid technical digression which clearly shows the application of the technique to the production process.

This reviewer sees unlimited possibilities for this book as a basic college text to introduce the concept of process dynamics into chemical engineering curricula at the senior or graduate school level. However, its immediate impact will be felt among the legion of plant instrument engineers who work with process design groups and process engineers who have responsibility for control system design and who are fairly well steeped in servo theory. These are the men who today carry the burden of breaking with tradition.

Reviewed by Lloyd E. Slater, Foundation for Instrumentation Education and Research, New York, N. Y.

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PEOPLE . . .

LETTERS: PRO & CON

C. H. CHILTON

Pro: Bare Cost Data

Sir:

The objections raised by Norman Bach regarding data on installed equipment costs (Oct. 20, pp. 214-215) are real, and I hope that you will heed his advice.

We had the same experience in 1950 when Robert Newton and I published privately our book, "Chemical Engineering Cost Estimation," with graphs on installed costs. We received so many comments along the same lines as Mr. Bach's that we reverted to bare costs in the edition published by McGraw-Hill in 1955.

The experience of our firm in many different situations involving installation costs, particularly outside the U. S., confirms the wide variation which can exist in them, thus limiting the usefulness of such data.

ROBERT S. ARIES
Aries Associates
Stamford, Conn.

Sir:

I would like to add my voice to that of Norman G. Bach in asking for "purchased cost" data in your *CE* Cost File series.

My company does quite a bit of overseas work, where labor costs are entirely different from those in the U. S., so that installed cost figures have little meaning. We can always add the foreign labor installation costs, and even multiply U. S. purchase prices by a factor if the equipment is to be fabricated overseas, so that purchase prices are definitely more useful in my opinion.

STANLEY S. GROSSEL
Chemical Construction Corp.
New York, N. Y.

► *Opinion on this question is divided, as witness the following letter.*—ED.

Pro: Installed Cost Data

Sir:

Relative to the cost basis—installed vs. delivered for use—installed costs are still our final objective. We use published graphs, tables and charts for rough, order-of-magnitude estimates. Since these are always also rush jobs, we find installed costs most helpful.

When you have more time to estimate installation costs peculiar to your specific problem, then you also have time to get the manufacturers' estimates of delivered costs.

Publication of both equipment *and* installation costs would, of course, extend usefulness of the cost data. Both types of data should be available, since one follows the other.

G. R. COUCH
American Metal Climax
New York, N. Y.

Pro: Smaller Columns

Sir:

We would be grateful if you would publish a correction of the dimensions of the absorption-oxidation columns in our La Madeleine nitric acid plant.

Instead of the 15-ft.-dia., 70-ft.-high figures which one of our people gave you earlier, the correct dimensions are 13 ft. dia. and 58 ft. high. This is an important point, since the small volume of the columns is one of the characteristics of our process.

J. BROCART
Etablissements Kuhlmann
Paris, France

Pro: Better Fileability

Sir:

You have again slipped into the custom of putting articles back to back so that it is impossible to remove them for filing. For example, in your October 6 issue, pages 141 and 142 both deal with costs and economics, yet they involve separate and distinct subject matter which should properly be filed separately.

The above is merely a single example. During the past six months or so the number of such

occurrences has been increasing.

You may have some sound reason for editorial arrangement like this and may have explained it in some prior issue, but I did not see that and have not been able to reconcile the practice. Although it constitutes just a little bit more trouble, I know that back-to-back articles of this sort can be avoided, and I sure would like to see you do something about it.

Incidentally, I rather like the biweekly frequency and have been quite pleased with many of the articles which have been appearing the past six or eight months.

W. A. CUNNINGHAM
University of Texas
Austin, Tex.

▶ *Yes, we plead guilty to backsliding in this matter of fileability of feature articles.*

We wish that the remedy was as simple as Prof. Cunningham makes it appear. The truth is that we, like many of our readers, have been operating under a tighter budget this year. This imposes limitations on our ability to publish all articles in fileable units.

As economic conditions improve, we pledge ourselves to correction of this temporary inconvenience to our readers.—ED.

Pro: General Engineering

Sir:

Opinions in Mr. Allen's letter (Oct. 20, p. 211) support a viewpoint I've had for years, viz., most engineers should graduate as just plain engineers without any attempted specialization. If necessary, specialization can come in graduate work.

I graduated as a civil engineer, with heavy emphasis on structures because the head of the department happened to be a structures man. So what happened? After one year with a state highway department, I took a job with an oil company in a refinery and have been in that line ever since. I wish now I had received more training on pumps, pressure-vessel design, piping design, heat transfer, etc., and less on structures, water supply, sewage disposal and airport design.

My contention is that very few college students have any clear and definite idea as undergraduates what line of work they'll get into or will like. Give them a well-rounded, workable education which will enable them to pick up the details and special procedures in any line of engineering work.

In our fast-moving economy, the industries that offer the best opportunities tomorrow may be practically unknown today.

WARREN O. CARLSON
C. W. Nofsinger Co.
Kansas City, Mo.

Con: Verbal Monstrosities

Sir:

I would like to voice my complete agreement with the letter of Mr. Ewing in your Oct. 20 issue (p. 215) regarding the use of the verbal monstrosity "continuize."

Just because we are engineers we do not have to be morons as far as our use of the English language is concerned. "Continuize" is incorrect, meaningless and ugly, and "continue" would have conveyed the correct meaning. If the suffix "-ize" implies to render or make like, then I beg you to let me know whether or not the process in question was continued or did they just have a sporting shot at it.

Speaking with the tongue in my cheek, as did Mr. Ewing in his last paragraph, unless your articles are written in comprehensible English, I will cancellize (making like but not actually carrying out) my subscription to your otherwise excellent magazine.

WILLIAM L. GROSS
New York, N. Y.

▶ *We trust that Mr. Gross will continue his subscription to Chemical Engineering, although it would be pretty difficult to "continuize" what is now essentially a batch operation with a biweekly (14-day) cycle.*—ED.

Pro: Sense of Humor

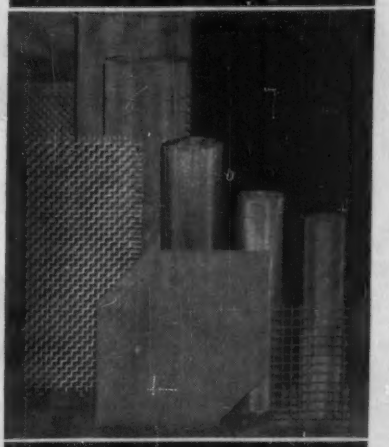
Sir:

Re your comment on Mr. Ewing's use of word "finalize" (Oct. 20, p. 215), don't you know when you are being kidded?

R. HAZELTON
Allied Chemical Corp.
Hopewell, Va.

▶ *We hope that Mr. Hazelton's comment "finalizes" the issue brought up by our coining the word "continuize."*—ED.

from a small piece



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29-30c *U.S. Industrial Chem. Co.

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* From advertisement, this issue

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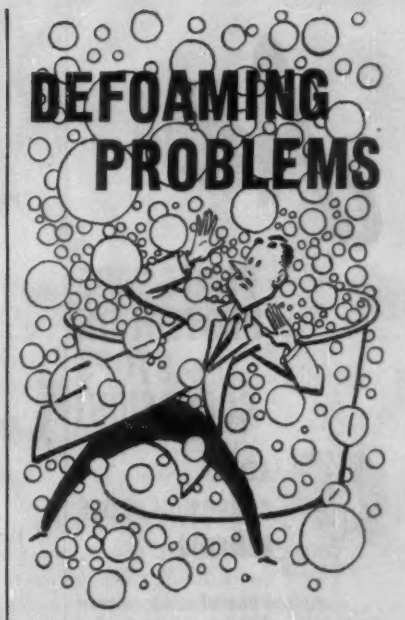

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220D Nuclear-Chicago Corp.

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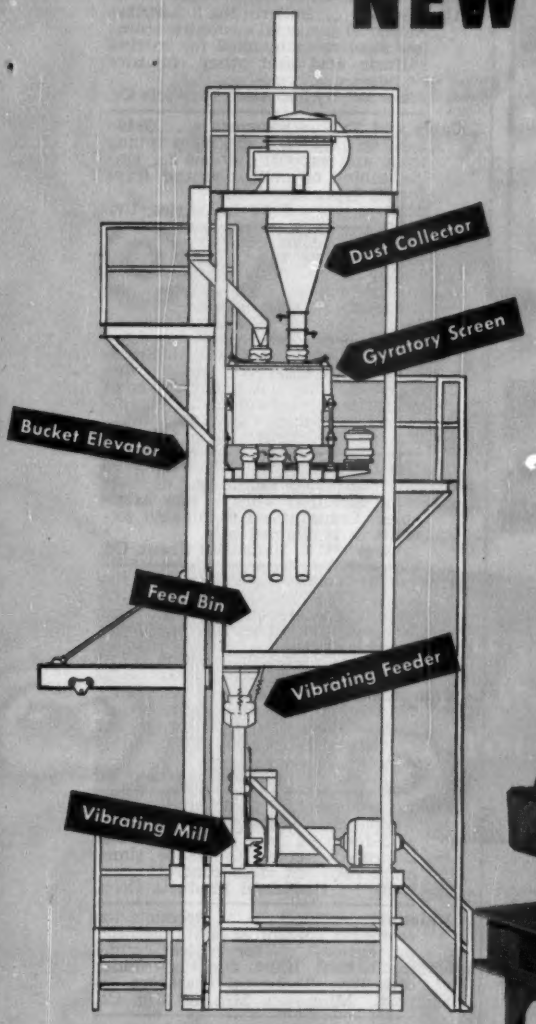
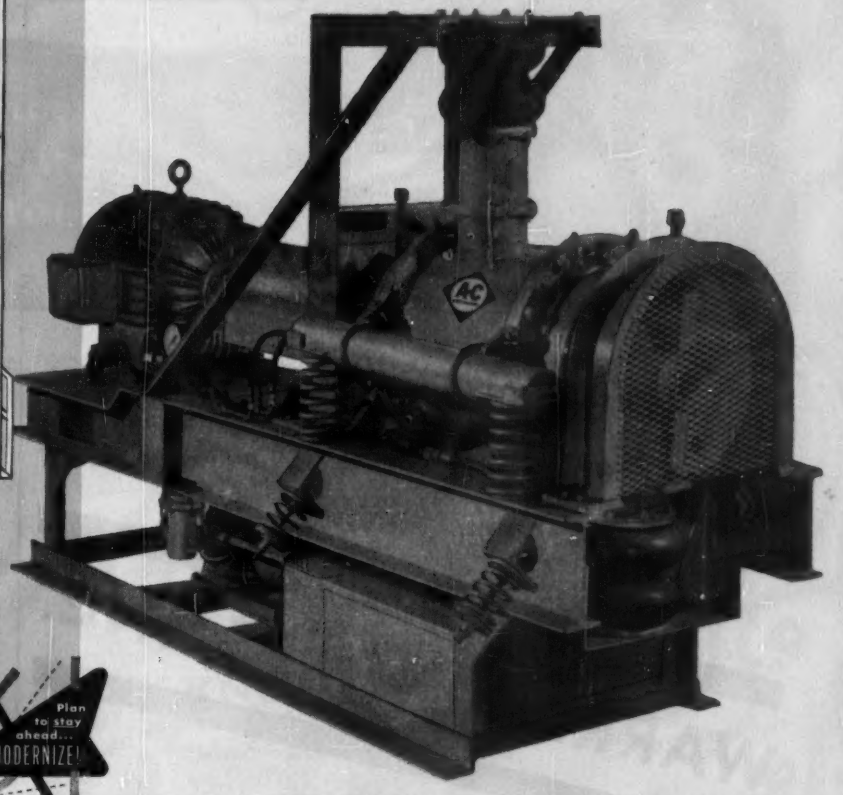
You can now process as much as one ton per hour of dry materials within less than 127 square feet of floor space with this new Allis-Chalmers Grinding Plant. Plant components are designed, applied and "coordineered" to handle materials in a 30 to 300 lb per cu ft range. Vibrating mill out-produces a tumbling mill 15 to 30 times per unit volume. The plant is a complete pre-engineered "package" that affords the low price tag of an off-the-shelf item, and built-in flexibility offers tailored-to-the-job performance.

Operating economy, accessibility, cleanliness and easy maintenance of the entire plant are other advantages.



Plant includes structural steel, platforms, ladders and processing equipment, motors, and drives — everything match-marked for convenient erection.



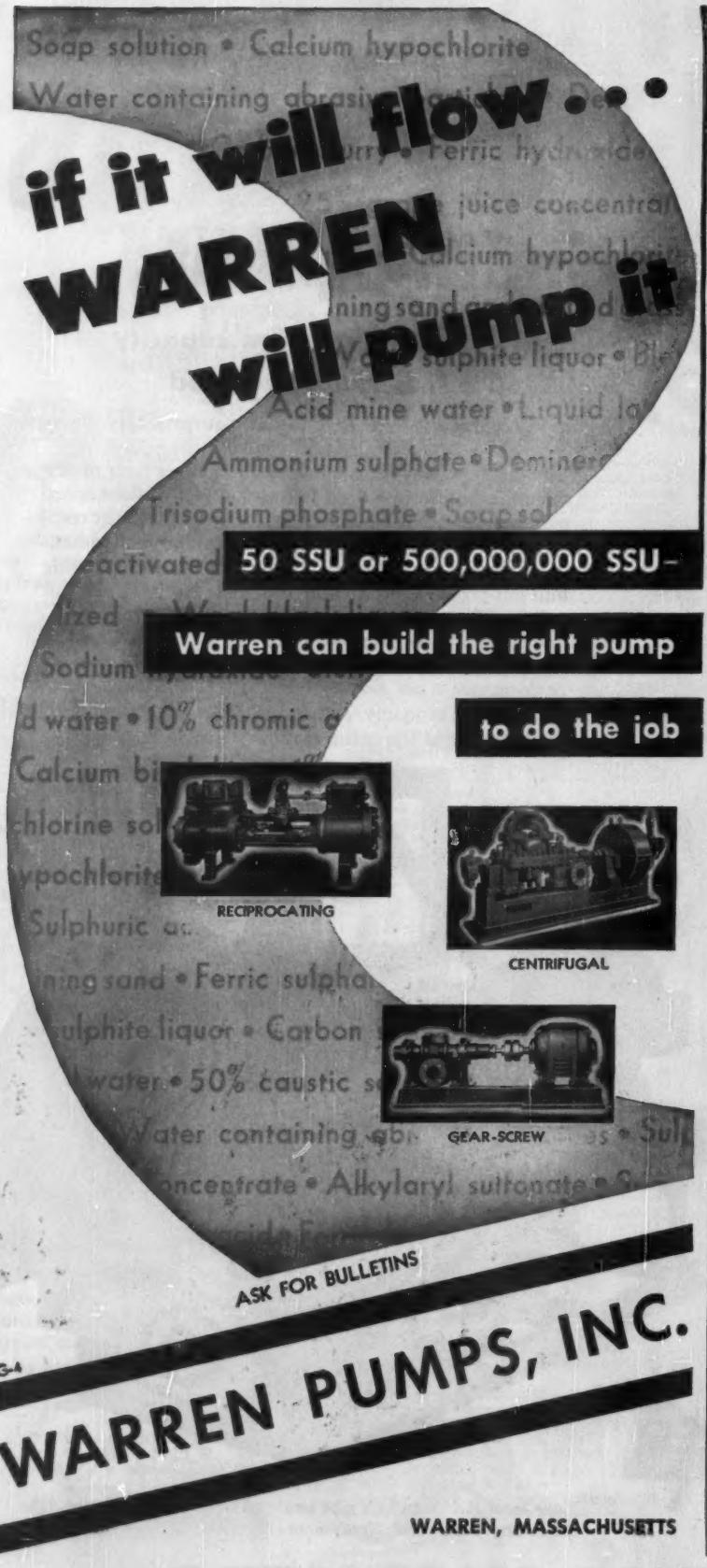
Plan to stay ahead... MODERNIZE!

Your local A-C man will give you all the details. Or, write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis.

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

A-5849



LITERATURE . . .

Vitamins.....Bulletin No. 4 outlines Amino Acids, Minerals and Drugs that are available. Equipped to take care of all your chemical problems. Send for your copy.
220H Crippen & Erlich Laboratories

Construction Materials

Alloy Steel.....Bulletin No. 8 describes Aloyco 20, a special austenitic stainless steel recommended for valving sulfuric acid and other corrosive liquids.
222A Alloy Steel Products Co.

Cable and Tubing Supports.....Catalog illustrates and describes tubing trays and support systems for single tubing or multitube and trays for all types of cables.
222B P-W Industries, Inc.

Castables.....Alundum castables are made in two types, Insulating & Heavy duty. Both are successful in protecting high temperature processing. Folder is offered.
54 *Norton Company

Coatings, Dispersion.....Halofluorocarbon coating system offers corrosion engineers a combination of properties; thermal stability, dielectric strength, etc. Bulletin.
222C Minnesota Mining & Mfg. Co.

Contact Cement ..... Water-thinned type for plastic laminating & other rapid assembly work is now available. Contains no flammable solvents & is claimed safe.
29-30m *U.S. Industrial Chem. Co.

Equipment, Rubber & Plastic.....fittings, valves & linings in high-impact, rubber-plastic. Economical & insensitive to corrosives. Write for information.
204 *American Hard Rubber Co.

Fabrication.....Brochure "Working With Metal" gives factual information on designing, engineering and specialized fabrication in chemical processing.
226 *The Boardman Co.

Floor Covering.....Bulletin describes comparative tests of Neotex, an acid-resisting floor covering. Tests indicated Neotex to be 50 times more resistant than concrete.
222D Crossfield Products Corp.

Halofluorocarbon ..... Products for corrosion control & contamination prevention . . . for critical equipment that must function under difficulty. Technical literature.
222E Minnesota Min. & Mfg. Co.

Insulation.....Foamglas insulation is waterproof, vapor-proof, acid-proof, vermin-proof & dimensionally stable. Complete information in latest industrial catalog.
16 *Pittsburgh Corning Corp.

Lead.....is one of the most efficient & economical protection materials against many acids. The Lead Handbook for the Chemical Process Industries is offered. Bul. 162.
225 *Federated Metals Div. of Asarco

Linings, Plastic.....Fluorocarbon linings are impervious to all the most difficult acids, alkalies & other highly corrosive chemicals. Details in Bulletin AD-152.
211 *U. S. Gasket Company

* From advertisement, this issue

BULLETIN 383

gives you the inside story

on Buflovak's agitated film Roto-Vak—

a new advance in high density heat transfer

Bulletin 383 is yours for the asking. Your copy will show you how this new Roto-Vak can handle viscous, foamy or heat sensitive materials with new efficiency, lower cost.

Bulletin 383 points the way to new opportunities as it shows how this Roto-Vak provides high density concentration of a whole range of new materials. Roto-Vak can widen your processing and product horizons. Get your copy today.

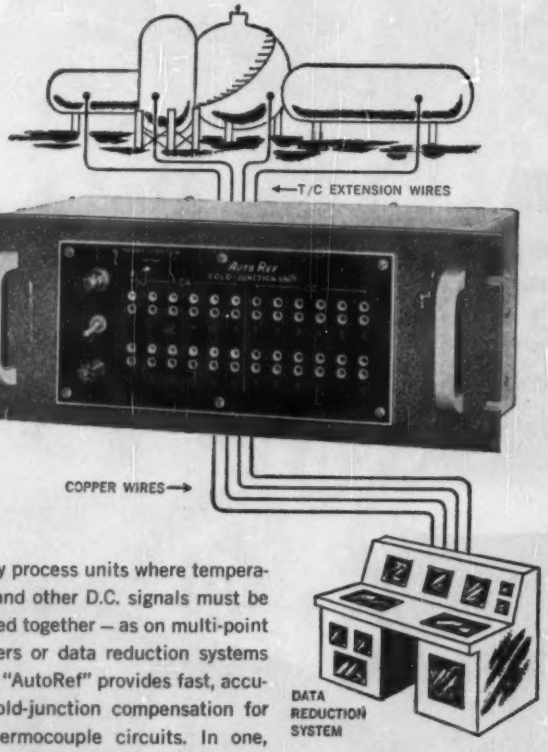
BLAW-KNOX

BLAW-KNOX COMPANY
Buflovak Equipment Division
1551 Fillmore Avenue • Buffalo 11, New York

T-E's *AUTOREF*® Provides

Cold Junction Compensation For Many Thermocouples

Ideal For Data Reduction Systems



For any process units where temperatures and other D.C. signals must be recorded together – as on multi-point recorders or data reduction systems –T-E's "AutoRef" provides fast, accurate cold-junction compensation for the thermocouple circuits. In one, compact unit it gives you constant, pre-determined, cold-junction reference for many thermocouples – actually up to several hundred. Typically, cold-junction temperatures can be controlled to within ±1°F. over a wide range of ambient temperatures.

Besides its accuracy, the "AutoRef" offers tremendous convenience – saving both time and effort. Designed for panel rack mounting, it can be introduced anywhere in the thermocouple circuit – no matter where thermocouples and instruments are located. Whenever temperatures, pressures, flow-rates and other electrical and mechanical conditions are being recorded simultaneously, the "AutoRef" does away with the need for maintaining ice baths or making laborious correlations. It is available for all standard thermocouple calibrations.

Write for Bulletin 81-E

Thermo Electric Co., Inc.
SADDLE BROOK, NEW JERSEY
In Canada — THERMO ELECTRIC (Canada) Ltd., Brampton, Ontario

LITERATURE . . .

Metal, Corrosive-Resistant.....Horton-clad offers uniform thickness of clad & backing plate, integral & high strength bond, clean contaminant-free surface. Bulletin.
26-27b *Chicago Bridge & Iron Co.

Platinum Salts.....A complete list of platinum and platinum group salts and solutions is available on request. Other products include stainless steel & nickel tubing.
L242 *J. Bishop & Co.

Refractories . . . . . Included are the widely diversified monolithic materials, refractory brick of the entire alumina-silica series.
22-23
*Harbison-Walker Refractories Co.

Rubber Materials.....For the Chemical Process Industries a complete line of corrosion-resistant materials, equipment & services. Hard rubber pumps, pipe, & valves.
208 *The Luzerne Rubber Co.

Steel, Aluminized.....exhibits good corrosion resistance in handling air, superheated steam & vaporized organic & hydrocarbons at elevated temperatures. Literature.
56 *Armco Steel Corp.

Steel, Glassed.....Greater insurance against unexpected or unavoidable shock with Glasteel 59. Offers excellent acid resistance. Send for our new Buyer's Guide.
256 *The Pfaudler Co.

Steel, Stainless.....widest selection & range of stainless types, shapes & sizes. Big capacity abrasive saw assures cutting accuracy also flame-cutting facilities.
138 *Ryerson Steel

Tanks & Vessels, Aluminum.....feature corrosion resistance and excellent thermal characteristics. They are lightweight and are easy to fabricate. Brochure offered.
38-39 *Reynolds Metals Co.

Tantalum . . . . . "Corrosionomics", a journal of useful information for the solution of corrosion problems. Technical data on Tantalum, its uses & properties.
228 *Fansteel Metallurgical Corp.

Titanium.....Write for bulletin on corrosion resistant properties of titanium. Titanium liners & diptubes win over stainless steel shells and flanges.
122 *Mallory-Sharon

Wire Cloth.....A 94-page catalog & stock list gives the full range of wire cloth available, describes fabrication facilities & gives useful metallurgical data.
217 *Cambridge Wire Cloth Co.

Electrical & Mechanical

Drives.....On the new BH Drives you can change the Pfaudlerpac seals & stuffing boxes without entering the vessel, removing the drive or disturbing alignment. Bul. 972.
24-25d *The Pfaudler Co.

Explosion-Proof Lighting.....To acquaint the reader with some of the features of the AA-51 Series explosion-proof lighting fixtures, manufacturer offers Form 303.
224A Appleton Electric Co.

* From advertisement, this issue

Generators, Inert Gas.....with the famous industrial carburetor. Better quality control & increased safety, at lowest operational cost. Bul. I-10. Send for your copy.
83 *C. M. Kemp Mfg. Co.

Motor.....Super Seal motor design is completely unaffected by moisture, dust, dirt, oil, acids & alkalies. Available in any integral horsepower size. Data available.
17-20 *Allis Chalmers Mfg. Co.

Motor Development.....A new brochure, "59 ideas for modernization in 59" is available. Includes electrical modernization . . . a better way of getting variable speed, etc.
R220 *Allis Chalmers

Motors.....Explosion-proof chemical motors built with cast-iron housings to provide exceptional corrosion resistance to etching vapors & corrosive gases. Bul. 1050.
58 *The Louis Allis Co.

Motors, Corrosion-proof.....eliminate rusting motor problems. Bulletin B-2406 is available. Gives complete information on 1 to 125 hp motors. Send for your copy.
255 *Reliance Electric & Engr. Co.

Motors, Servo.....Bulletin gives applications data for standard and custom servo motors. Characteristics and installation drawings are included for sizes 08 to 23.
225A United Aircraft Corp.

Motors, Torque.....Six-page article describes special techniques and drive circuits used to get superior response and resolution from torque motors.
225B Raymond Atchley, Inc.

Motors, Tube Ventilated.....For big fans, blowers, pump drives . . . heavy duty applications where you need large motors with highly effective cooling systems.
63 *Wagner Electric Corp.

Power Switching Centers.....Pneumatic system, including nitrogen cylinder, air motors, & all controls, is mounted in a separate metal enclosed compartment. Information.
120 *I-T-E Circuit Breaker Co.

Turbines.....Bulletins are available which give complete information on multi-stage, solid-wheel and axial-flow impulse turbines. Sizes up to 5,000 horsepower.
106a *The Terry Steam Turbine Co.

Turbines, Steam.....ranging from 150 hp down to fractional, in 6 frame sizes. For low steam consumption, can be furnished with "L" type wheel. Bulletin 135.
123 *Coppus Engineering Corp.

Voltage Reference Sources.....Brochure discusses three models of ultra-precision voltage reference sources; portable decade, rack-mounting, and binary units.
225C Epsco, Inc.

Handling & Packaging

Barge Loading Arm.....is designed to reach approximately 20 feet from dock riser to barge flange. Total length of Arm is 25 feet. Facts in Bulletin No. 456.
43 *Chiksan Company

* From advertisement, this issue

Federated Lead Fights Corrosion! Federated lead is one of the most efficient and economical protection materials against many acids. Lead is self-healing. Scratch it and a protective coating re-forms immediately. Lead is easy to work and moderately priced. Federated produces chemical lead in sheets to your requirements. Pipe, bends, traps and standard fittings available from stock. Special forms fabricated to order. Call the Federated Sales Office near you. Or write for Bulletin No. 162, the Lead Handbook for the Chemical Process Industries. Federated Metals Division, 120 Broadway, New York 5. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

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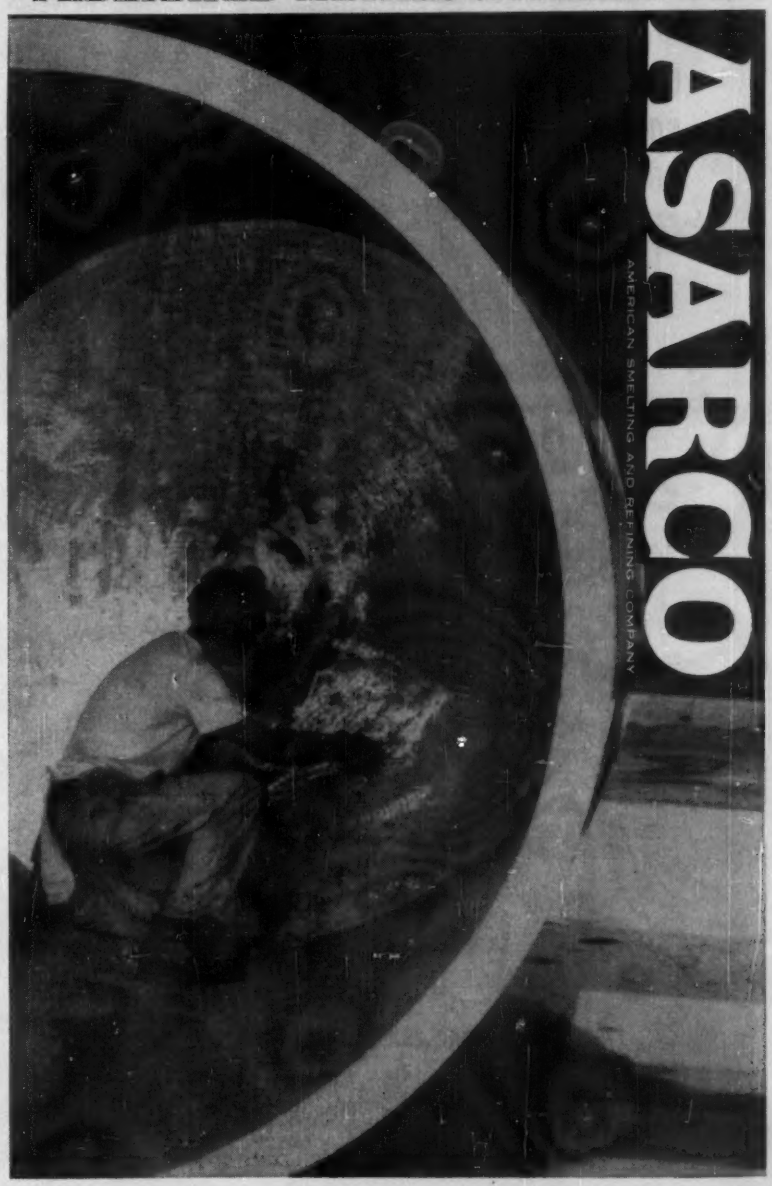

This Phillips Petroleum plant..

Phillips 66

uses this solids contact reactor shell...

built by BOARDMAN

If your company needs precision-built metal products, you can put Boardman's metalcrafting skill to profitable use The carbon steel reactor shell above, built to the specifications of the Cochrane Corporation for Phillips Petroleum's Andrews, Texas, gasoline plant, is another example of "Boardmanability."

Boardman's long experience in working with metals—carbon, high-tensile and stainless steels, wrought iron, aluminum and others—can make metal work for you. And Boardman can assist you in design and engineering, as well as in specialized fabrication. Call Boardman collect, for consultation or for quotes on your next chemical process project.

BOARDMAN

THE BOARDMAN CO.

OKLAHOMA CITY, OKLAHOMA

Write for the brochure "Working with metal . . . at Boardman"

LITERATURE . . .

Bottles, Polyethylene.....with rotating sleeve to protect label are now on market. Horizontal channels for the sleeve are molded around the bottle.
29-30f *U.S. Industrial Chem. Co.

Conveyor Components.....Recently introduced screw conveyor components reduce power demands and maintenance delays. Folder 2489.
12 *Link-Belt Co.

Conveyors, Tubular.....for moving bulk materials automatically, up, down, through walls, around corners & obstacles. Circuit Bulletin & Catalog 1258 offered.
T230 *Hapman Conveyors, Inc.

Materials Handling.....Complete data on the new model H-25 Payloader available. Handles more material per hour at less cost per ton. Carry capacity of 2,500 lbs.
8 *The Frank G. Hough Co.

Packer, Self-loading.....A 40-page book, "How to Cut Waste Disposal Costs," is offered. It contains cost-finding formulas, solutions to problems, case histories, etc.
124 *Dempster Brothers, Inc.

Packaging Machinery.....Literature covers eight product lines including fillers, check-weighers, carton fillers and sealers, wrapping equipment and forming machines.
226A FMC Packaging Machinery

Pneumatic Conveyors.....for handling bulk chemicals. Bulletin P58-G gives information on pneumatic conveyor systems for handling dry granular materials.
98 *National Conveyors Co., Inc.

Tanks, Chemstor . . . . . are ideal for sticky storage; they discourage clinging, scale, and product build-up like any glass container. Information in Bulletin 918.
24-25d *The Pfaudler Company

Heating & Cooling

Burners, Industrial.....Folder No. 5807 describes line of packaged burners equipped with built-in fuel and air systems. Available for gas, oil or duel fuel.
226B Iron Fireman Mfg. Co.

Coil, Heating.....Bulletin describes line of Herman Nelson Heating coils. Complete selection information as well as detailed descriptive literature.
226C American Air Filter Co.

Coil, Steam.....designed to provide uniform surface temperatures & precise temperature control, available in corrosion resistant stainless steel. Bul. M-10.
103 *Marlo Coil Co.

Coils, Water.....Type R coils are specially designed for installations where frequent mechanical cleaning of the inside of the tubes is required. Bul. No. R-50.
24b Aerofin Corporation

Heat Exchangers.....Readily assembled to handle any combination of liquids & gases. Can be used as a heater, cooler, condenser or vaporizer. Bulletin 302.5K1.
55 *American Standard

* From advertisement, this issue

Heat Exchangers.....Votator scraped surface units are available in sizes of 0.7 sq. ft. to 60 sq. ft. of heat transfer surface . . . capacities of 50 to 50,000 lbs/hour.
Cover *Girdler Process Equip. Div.

Heat Exchangers.....of titanium and zirconium construction. Fight corrosion in process qeuipment. Bulletin 949 describes full line of alloy heat exchangers.
24-25f *Pfaudler Co.

Heat Exchangers.....Bulletin discusses fully standardized, low-cost line of heat exchangers for production and pilot plant use. Specifications on 19 models.
227A Ross Heat Exchanger Div.

Heat Exchangers.....Catalog contains photographs and diagrams illustrating basic types of heat exchangers and pressure vessels, as well as other special items.
227B Southwestern Engineering

Heat Exchangers.....Bul. 817 describes VMC ammonia compressor. Blu. 707 condensers, brine coolers & heat exchangers. Information on industrial types in Bul. 427.
251 *Vilter Manufacturing Co.

Heat Transfer Equipment.....Bulletins No. 921 and 886 completely cover heat transfer equipment of Glasteel construction. Now available.
24-25c *The Pfaudler Co.

Heater, Steam.....Heat & agitate liquids in tanks, efficiently & economically. Bul. 3A-HC includes application information & data on sizes, dimensions & capacities.
207 *Schutte & Koerting

Kilns, Rotary.....Feature; self-aligning bearing pedestals, truly effective air seals & stationary firing hood. Built in any length or diameter.
252 *Kennedy Van Saun Corp.

Propane Diluter.....Accurately mixes fuel gases with air to supply standby fuel, and to maintain operations when regular facilities or supplies fail.
227C Selas Corp. of America

Steam Trap.....New Impulse features closer shut-off, quieter operation due to lever action & stainless steel construction. Bulletin is available.
117 *Yarnall-Waring Co.

Thermo-Panels.....Weigh less & take less space. Complete technical data including many valuable tables are contained in the literature available.
TL240 *Dean Products, Inc.

Tubes. Heat Exchanger.....for longer service the tubes have a full range of copper-base alloys for every application. Give complete control of quality.
34-35 *Phelps Dodge Corp.

Vaporizers.....High-temperature, low-pressure vapor & liquid phase process heating applications with vaporizers & heater for Dowtherm described in Bulletin A-100.
234 *Eclipse Fuel Engineering Co.

Instruments & Controls

* From advertisement, this issue

FLEXIBILITY of operation, providing ANY COMBINATION of products, liquid or high pressure gas PLUS simultaneous production of BOTH oxygen and nitrogen delivers maximum yield of combined products at minimum cost of operation with little operator's attention. Packaged design requires minimum of installation cost and space.

This most modern and efficient design from Independent combines the best features of the earlier two-product package plants pioneered by Independent with the latest concepts of external refrigeration. Type illustrated in 1500 to 5500 cu. ft. per hour capacities. Other types in larger and smaller sizes. Pure argon available on larger sizes.

We invite your Inquiry

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Corrosionomics

REGISTERED U. S. PATENT OFFICE

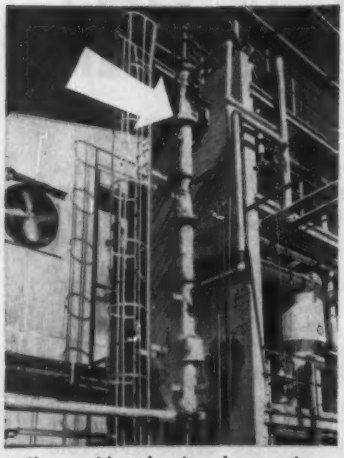
A JOURNAL OF USEFUL INFORMATION FOR THE SOLUTION OF CORROSION PROBLEMS

TANTALUM HEAT EXCHANGER SOLVES HIGH TEMPERATURE HNO_3 PROBLEM

Commercial Solvent's plant at Sterlington, La., produces flake ammonium nitrate by neutralizing nitric acid with anhydrous ammonia. The reaction takes place at 400-460°F., driving off water introduced with the acid. A key piece of equipment in this operation is a Fansteel tantalum heat exchanger which has been giving outstanding service with no visible corrosion noted over a number of years.

Handles HNO_3 at 45 Gal/Min

This Fansteel equipment handles up to 45 gal/min at elevated temperatures with a heat transfer coefficient greater than 550 Btu/hr/sq ft/°F. It is made of three 8-ft. sections in series. If one unit must be removed the other two may be coupled and run at reduced flow. Each unit consists of a bundle of 19 straight tantalum tubes, ½" O.D. and with a 0.015" wall. This gives 20 square feet of heat transfer surface for each section.



Shown without lagging, three-section tantalum heat exchanger raises nitric acid temperature to 330°F.

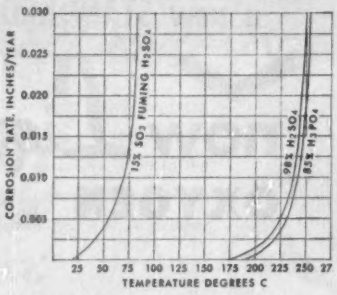
Corrosion Rate Nil in HNO_3

Montecatini, the huge Italian chemical company in Milan, exposed tantalum to 98% HNO_3 containing 0.1% H_2SO_4, 0.4% nitrogen oxides and 1.5% H_2O at 132°C for 762 hours. The corrosion rate was 0.00002 inches per year and the metal was unchanged in appearance. Tests by other companies confirm the low corrosion rates of HNO_3 in all concentrations even at elevated temperatures—as high as 200°C.

"U" Tube Bundles Also Available

Fansteel heat exchangers are also available with "U" tube bundles where processing or physical requirements call for a unit with input and output at the same end. No internal gaskets are used, which makes the leakage problem nonexistent. Teflon* grommets support each tube in the baffle holes and permit free movement, thereby eliminating the differential expansion problem.

Tantalum Also Resistant to Concentrated H_2SO_4 and H_3PO_4



Free Tantalum Test Kit

A corrosion test kit, available without charge to research technicians, if requested on your letterhead; contains both tantalum sheet and wire.

Free Technical Information

The above condensation is typical of the articles which appear in CORROSIONOMICS, a Fansteel publication. Mail us your name for inclusion on our free mailing list.

G584A

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For further data on the above, write:

FANSTEEL METALLURGICAL CORPORATION

CHEMICAL EQUIPMENT DIVISION

NORTH CHICAGO, ILLINOIS, U. S. A.

LITERATURE . . .

Annunciators.....Representing a radical departure from conventional systems, Scannit annunciators are a completely self-contained static switching circuit.
227D Scam Instrument Corp.

Analyzer, Oxygen.....Bulletin 0704-1 presents an improved Type 3 continuous oxygen analyzer with a new automatic calibrator. Explosion-proof detector described.
228A Mine Safety Appliances Co.

Analyzers, Process.....Two brochures are available, describing spectrochemical analyzers—an x-ray fluorescence analyzer and an x-ray polychromator.
228B Applied Research Lab.

Controller.....Complete information on liquid level transmitter for slurries, paper stock & viscous or corrosive fluids is contained in Bulletin F-115.
113 *Fisher Govern Company

Compressor Controls.....New engineering application bulletin provides information on automatic controls for compressors. Entitled "EnTronic Pipeline Control."
228C Cooper-Bessemer Corp.

Data Reduction System.....The "AutoRef" provides fast, accurate cold-junction compensations for thermocouple circuits. Bulletin 81-E gives complete information.
224 *Thermo Electric Co., Inc.

Gas Chromatography.....Data sheet covers techniques for increasing quantitative accuracy in gas chromatography. Gives advantages of integrated area measurement.
228D Beckman/Scientific

Grinder Recorder.....Brochure discusses the modified Electric Ear, an electronic device for regulating feed rate to grinding mills; unit also records mill operations.
228E Hardinge Co., Inc.

Instrumentation, Nuclear.....A linear count rate meter, precision binary scaler and linear amplifier are described in three new technical bulletins.
228F Borg-Warner Corp.

Instrumentation.....Electronic Consotrol is a counterpart of its world-famous pneumatic Consotrol line. For the full story on this process control, Bul. 21-10.
14-15 *The Foxboro Co.

Meters, Liquid.....wherever liquids are batched blended or transferred. Complete data on meters for all your needs is contained in Bulletin 566 B.
241 *Neptune Meter Co.

Process Vapor Fractometer....."Automatic Plant Stream Analysis" gives complete information on Model 184. It gives new control over alkylation efficiency.
189 *Perkin-Elmer Corp.

Punch-Card Process Control.....Condensed two-page bulletin describes a low-cost punch-card control system for volumetric or gravimetric systems.
228G The Jordan Co., Inc.

Pyrometer . . . . . You can accurately read any low surface temperature with Type 2300 Surface Pyrometer in 3 to 5 seconds. Complete story on full line in Bul. 4257.
244 *Illinois Testing Lab.

* From advertisement, this issue

Recorder-Controller.....unit continuously & simultaneously records four variables on the same chart. Offers clear, easy-to-read records for continual analysis & control.
116 *Bailey Meter Co.

Recording Annunciator . . . . . Bulletin 102 describes and illustrates a new recording annunciator that features low operating costs and reduced maintenance.
229A Panellit, Inc.

Sample Systems.....A new bulletin, M-S-A Sample Systems and Accessories for Gas Analysis lists applications, features & advantages for the complete line.
59 *Mine Safety Appliances Co.

Spectrophotometer.....Brochure describes what infrared is and how it is used for the identification of unknowns, product control and analysis. Infracod described.
229B Perkins-Elmer Corp.

Spectrophotometer, Infrared.....New bench model has KBr prism, permits chemical analysis in the 12.5-25 micron region. Yields quantitative & qualitative information.
29-301 *U.S. Industrial Chem. Co.

Temperature Controller.....Brochure describes how the simple mechanical design of a temperature indicating controller offers several different advantages.
229C Fenwal, Inc.

Thermocouple Assemblies . . . . . Each component comprising several thermocouple assemblies is described. Assemblies cover temperatures from —300 to 2,200 F.
229D ThermoElectric Co.

Thermocouple Wire.....Provides electrical insulation up to 2,500 F. Single or double conductors encased in special ceramics and surrounded by metal sheaths.
229E Continental Sensing, Inc.

Pipe, Fittings, Valves

Connectors, Flexible.....A new stock answer to pipeline problems caused by rigid connections. Feature corrosion & pressure resistance. Fact-filled Allflex Bulletin.
B230 *Allied Metal Hose Co.

Connectors, Flexible . . . . . Made of Teflon covered by metallic braiding and fitted with permanently swaged fittings of all description are discussed in Bulletin TC-101.
229F American Metal Hose Div.

Fintubes.....Bulletin No. 511 gives information on materials & sizes, applications, and complete engineering data on integral "one-piece" fintubes. Illustrated.
229G Brown Fintube Co.

Fittings.....Weldolet fittings feature improved flow conditions & easy economical installation. Detailed information on the complete welding fittings available.
214 *Bonney Forge & Tool Works

Fittings.....Welding fittings of any material available in plate that can be worked & welded. A new bulletin with complete information is offered. Bul. 5801.
107 *Midwest Piping Co., Inc.

† From advertisement, this issue

SPERRY

is the low cost answer to all your FILTRATION PROBLEMS

Consider all the money-saving aspects of a Sperry Filter Press. These include low initial cost . . . nominal installation . . . minimum maintenance . . . low depreciation . . . and an economy of operation that extends through many years of trouble-free performance.

However complex your filtration problems may be, these economies are basic to the solution.

You can avail your plant to the economies of a Sperry Filter Press, custom-engineered to meet your particular requirements for flow rate, cake build-up, washing, extraction, thickening, etc. Variations are provided, offering center, side or corner feed; open or closed delivery; simple or thorough washing; high or low temperature control. Plates may be had in aluminum, wood, iron, bronze, stainless steel, lead, rubber, nickel or any other special materials to meet your requirements. Any filter media can be used . . . cloth, synthetics, wire screen . . . paper. Labor-saving plate shifting devices and semi-automatic closing attachments are adaptable for any model . . . to increase production, minimize operation hazards and reduce wear and tear.

FOR A LOW-COST ANSWER TO YOUR FILTRATION PROBLEMS, SEE THIS SPERRY CATALOG . . . an up-to-date fully illustrated reference manual of erection, operating, design and construction data and specifications. Mail coupon for your free copy today.

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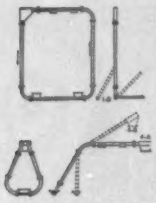
CE-6

Examples of a few typical circuit plans.



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Patented SEALED-PIN CHAIN DESIGN keeps abrasives out—quadruples chain life.

Hapman TUBULAR CONVEYORS

Move almost any flowable material—wet or dry—through any plane or angle . . .

Make *big savings!* Move bulk materials *automatically*—up, down, through walls, around corners and obstacles with a Hapman! Circuits like these or complex layouts engineered to *your* needs. Usually a *single* drive unit serves where other conveyors need several. Design cuts costs. Dust and liquid *tight!*

WRITE for Circuit Bulletin and Catalog 1258

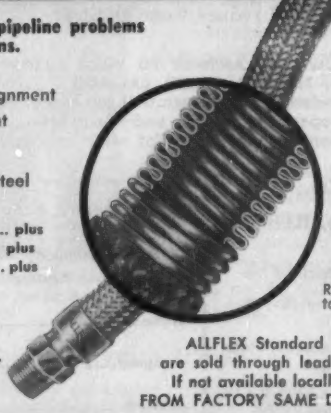
Hapman CONVEYORS, INC.

KALAMAZOO MICHIGAN

In British Commonwealth & Europe: Fisher and Ludlow Ltd., Birmingham

Allflex

STAINLESS STEEL "MNH" FLEXIBLE CONNECTORS



A NEW stock answer to pipeline problems caused by rigid connections.

- Dampens Vibration
- Compensates for Misalignment
- Permits Offset Movement
- Absorbs Expansion

With ALLFLEX Stainless Steel Connectors you get:

- CORROSION RESISTANCE .. plus
- PRESSURE RESISTANCE . . plus
- CORROSION RESISTANCE . . plus
- FLEXIBILITY

Also available in Monel, Bronze and Steel.

WRITE TODAY for fact-filled ALLFLEX Bulletin

THESE STOCK SIZES

¼" ⅜" ½" ¾" 1" 1¼" 1½" 2"

IN THESE STOCK LENGTHS

12" 18" 24" 30" 36" 48" 60"

. . . also available in all standard sizes, in any required length, with any standard or special fitting or flange. Full engineering information on ALLFLEX Stainless Steel Hose can be found in: Chemical Engineering Catalog, pages 153 to 156; Refinery Catalog, pages 169 to 172 (Allied A, B, C, D)

ALLFLEX Standard Stainless Steel Connectors are sold through leading Industrial Distributors. If not available locally—THEY CAN BE SHIPPED FROM FACTORY SAME DAY ORDER IS RECEIVED.

ALLIED METAL HOSE COMPANY

3732 Ninth Street, Long Island City 1, New York • Stillwell 4-5173

LITERATURE . . .

Fittings.....Speedline fittings feature flange without welding, leakproof union joints and easier, faster alignment. The Speedline Catalog is offered.
97 *Horace T. Potts Co.

Flanges.....A 36-page pocket reference booklet contains useful data on flanges in forged steel or special models in carbon or alloy steel. Also information on expansion joints.
46 *Phoenix Mfg. Co.

Nozzles.....for a perfect spray, many food processing plants. Applications to wax fruits, powdered milk, wash filter cake & humidify banana rooms. Catalog 1.
216 *Monarch Mfg. Works, Inc.

Packings Polyethylene.....for Cooling Towers. These polyethylene "rosettes" give 20-40% greater cooling efficiency and they are corrosion-resistant.
29-30d *U. S. Industrial Chemicals Co.

Pipe.....Bulletin TS-1A gives complete details on fluoroflex-T pipe. It resists corrosion, and can handle hydrofluoric acid with complete safety & no maintenance problems.
191 *Resistoflex Corp.

Pipe, PVC.....is available in sizes ¼" through 6" in schedules 40, 80, and 120. A new 32-page illustrated catalog on this pipe is available.
77 *A. M. Byers Co.

Pipe & Tubing.....For quick reference, a wall chart listing comparative corrosion resistance data on Zirconium, Titanium, Tantalum, Hastelloy C alloy etc.
10-11a *Damascus Tube Co.

Pipes, Plastic.....Bulletin CE-50 contains 20 valuable pages...comparable properties, chemical resistance, costs, etc. of 11 plastics & rubber materials.
205 *American Hard Rubber Co.

Rupture Discs.....offer wider rangeability in selection of metals & plastics for disc components. Feature rugged construction for protection against damage.
213 *Black, Sivalls & Bryson, Inc.

Tubing.....Crescent Armored Multitube is available in size ¼" O. D. in lengths to 1000 ft. in from 2 to 37 tubes. Solves corrosion problems.
T232 * Crescent Insulated Wire & Cable Co.

Tubing.....New Handbook on super corrosion-resistant & nuclear metals. Contains applications, corrosion data, chemical analysis & physical characteristics.
10-11b *Damascus Tube Co.

Tubes, Pressure.....available in all stainless & alloy grades to meet almost any combination of operating conditions. Available in sizes up to 11" O. D. x 3" wall.
115 *Timken Roller Bearing Co.

Valve.....Folder No. 207 describes the Outside Screw & Yoke U-Bolt Gate valve....All-Iron & Ni-Resist with type 316 Stainless Steel trim. Send for your copy.
53 *Jenkins Bros.

Valves.....Three & four way valves are suitable for piloting cylinder operated valves. Complete information is contained in Bulletin 8344X. Send for your copy.
127c *Automatic Switch Co.

* From advertisement, this issue

Out of these ovens comes a new concept in American missiles

It's a black rubbery solid, known technically as cured polysulfide polymer and popularly, as solid rocket propellant.

Until recently America staked its missile and rocket program on liquid fuels.

But the Thiokol Chemical Corporation of Trenton, New Jersey, stuck by the unpopular theory that solid rocket fuel was not only feasible but actually more practical than liquid fuel.

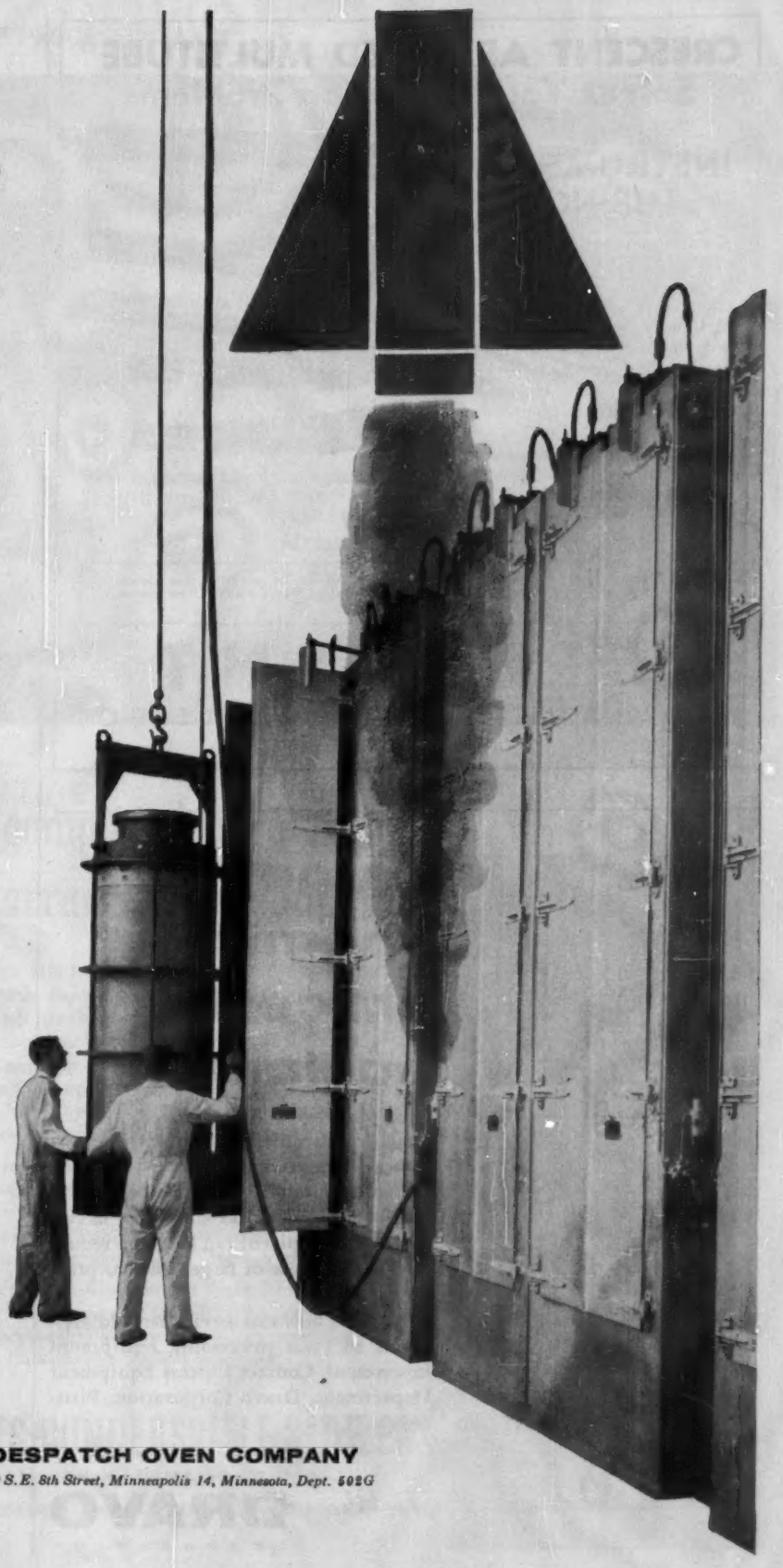
The "unpopular" theory was tested and proved. Now, prospects are that the rockets of the future will be propelled into space by this black rubbery substance that a few short years ago was used only for making oil and gasoline hoses.

Already the 500-mile Pershing missile, the booster stage of the Army's Nike-Zeus anti-missile missile, and the Air Force Bomarc surface-to-air ramjet missile are slated for solid fuel. And in the offing is a solid-propelled ICBM.

In Thiokol's Marshall, Texas, plant these steam-heated Despatch Ovens cure a combination of propellant mix and liquid polymer to solid fuel inside the rocket engines. The ovens are also used to cure engine linings and to preheat cores before the casting operation.

You may not make missiles or missile components. Few of us do. But you may have a baking or curing operation similar to Thiokol's. Despatch is at your service with unmatched experience in the heat processing field—50 years and 50,000 installations.

For complete information and specifications on any type of installation, write or call:

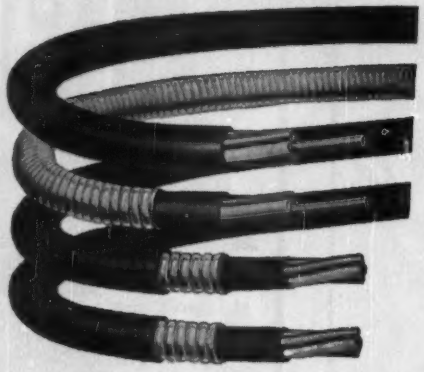


DESPATCH OVEN CO.

DESPATCH OVEN COMPANY

619 S.E. 8th Street, Minneapolis 14, Minnesota, Dept. 502G

CRESCENT ARMORED MULTITUBE®
Solves Your Corrosion Problems
for
INSTRUMENT TUBING



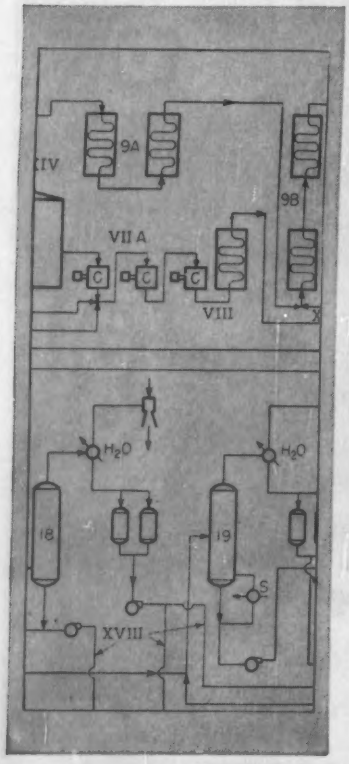
A corrosion proof sheath of Polyvinyl chloride over SPIRALLY CABLED copper or aluminum instrument tubing provides complete moisture and corrosion protection for the tubes. Flexible galvanized steel armor in various combinations, as shown, gives mechanical protection for permanence with handsome savings in installed cost.

Available in size ¼" O.D. in lengths to 1000 feet in from 2 to 37 tubes. Licensed under U. S. Patent #2,578,280.

SEND FOR NEW BULLETIN

Plastic Coated Single Tubes, copper or aluminum, should be used to give corrosion protection to all single lines up to the final tube fitting, where trouble from corrosion may occur.

CRESCENT
INSULATED WIRE & CABLE CO.
Trenton, N. J.



Large chemical process equipment

designed and built by Dravo's experienced team of engineers and production men, can often mean large dollar savings to your company. Dravo's know-how in custom-built equipment can help you reduce costs through use of large, efficient processing units.

Find out how this service can add dividends to your processing equipment investment. Contact Process Equipment Department, Dravo Corporation, Pittsburgh 25, Pa.

DRAVO
CORPORATION

LITERATURE . . .

Valves.....“Craneloy 20” valves for acid service. Circular AD-2080 will bring you up to date on corrosion-resistant alloy valves. No leakage, galling or seizing.
133 *Crane Company

Valves.....All kinds & types available in a variety of Nickel & Monel. Able to handle every flow requirement. Information on all models is available.
79 *The Wm. Powell Co.

Valves, Ball.....features a new remote control which can be operated on AC or DC current. Opens & closes valves instantly from any distance. Details in Catalog No. 57.
51 *Rockwood Sprinkler Company

Valves, Butterfly.....Features, advantages, dimensions, operators and technical characteristics of rubber-seated butterfly valves are discussed in Bulletin 650-R2.
232A Builders-Providence, Inc.

Valves, Control.....Bulletin LB-3 gives details on construction and operating characteristics of the Series LB control valve, a diaphragm-type unit.
232B Conoflow Corp.

Valves, Drain.....The Ram type drain valves cannot clog up whether in open or closed position. A catalogue containing complete information is offered.
200 *Strahman Valves, Inc.

Valves, Solenoid.....designed for missile applications with tough environmental or operational requirements. Publication V5056 for information.
127a *Automatic Switch Co.

Valves, Two-way.....normally open or normally closed, easily handle fluids at pressures to 3000 psi, temperatures to 350 F. Main illustration on Bulletin 8223X.
127b *Automatic Switch Co.

Welding Fittings.....Available in sizes ½" through 24". Schedules 5S through 160. Stainless types 304, 304L, 316, 316L, 347; Monel, Nickel, Aluminum.
6 *Flowline Corp.

Agitating Equipment.....New 16-page catalog introduces many new items sive line of laboratory and produc- which have been added to an extention agitators.
232C Eclipse Air Brush Co.

Air Cleaners.....Fourteen standard sizes of hydrocarbon vapor adsorption devices for cleaning and drying air are now available. Bulletin SC-1047.
232D Selas Corp. of America

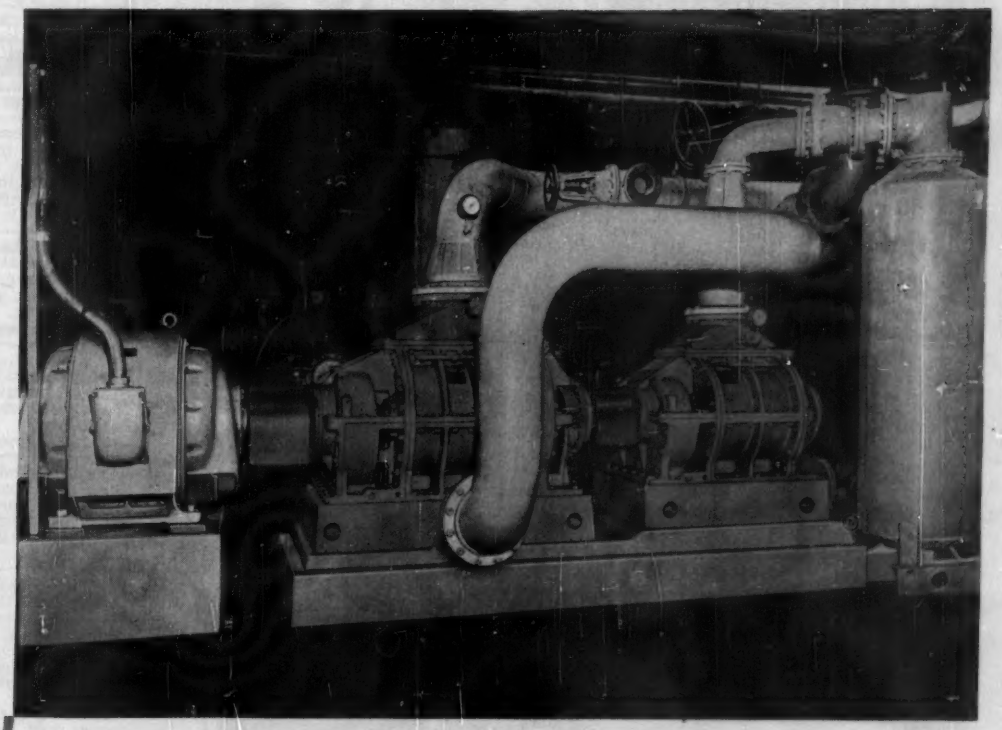
Aeration Ejectors.....Complete details about an aeration system that gives an answer to waste disposal and steam pollution problems. Provides 25% oxygen absorption.
232E Penberthy Mfg. Co.

Centrifugals.....A catalog is offered on the time-saving Batch-Master centrifugal. Rapid bottom discharge & hydraulic unloading save processing cycle time.
203 *Amer. Machine & Metals, Inc.

Centrifugals.....Catalog CE-58 gives complete information on size, type and capacities of “Ter Meer” centrifugals. Designs for every process in the chemical industry.
101 *Baker Perkins, Inc.

*From advertisement, this issue

FOR CHEMICAL AND ORE PROCESSING



RCV-2 vacuum pump—16x35 and 14x24 in compound arrangement, rated 7740 cfm at 22" Hg vacuum, operating at 900 RPM with 294 HP.

NEW R-C compound vacuum pump arrangement simplifies installation

With a new "straight-through" drive design for compound vacuum pump applications, Roots-Connersville has not only simplified piping arrangements but has also further reduced installation time and costs. This new development features a drive-through arrangement with the second stage pump driven directly from a shaft extension on the first stage pump. This permits the use of a standard single shaft extension motor drive. Other pump improvements provide for operation at higher speeds giving more CFM per dollar.

In addition to simplifying installation of the piping, this arrangement provides for easier servicing and maintenance of both pumps and motor. Installations of this new arrangement in chemical plants, uranium and taconite processing plants and paper mills have completely substantiated its advantages in long, uninterrupted performance.

Here is another reason why you can depend on Roots-Connersville equipment for vacuum service to deliver the finest overall performance and dependability at low cost . . . a reputation proved for generations in the country's leading industries.

For additional data, please refer to our section in **Chemical Engineering Catalog** or write for **Bulletin VP-158**

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A DIVISION OF DRESSER INDUSTRIES, INC.

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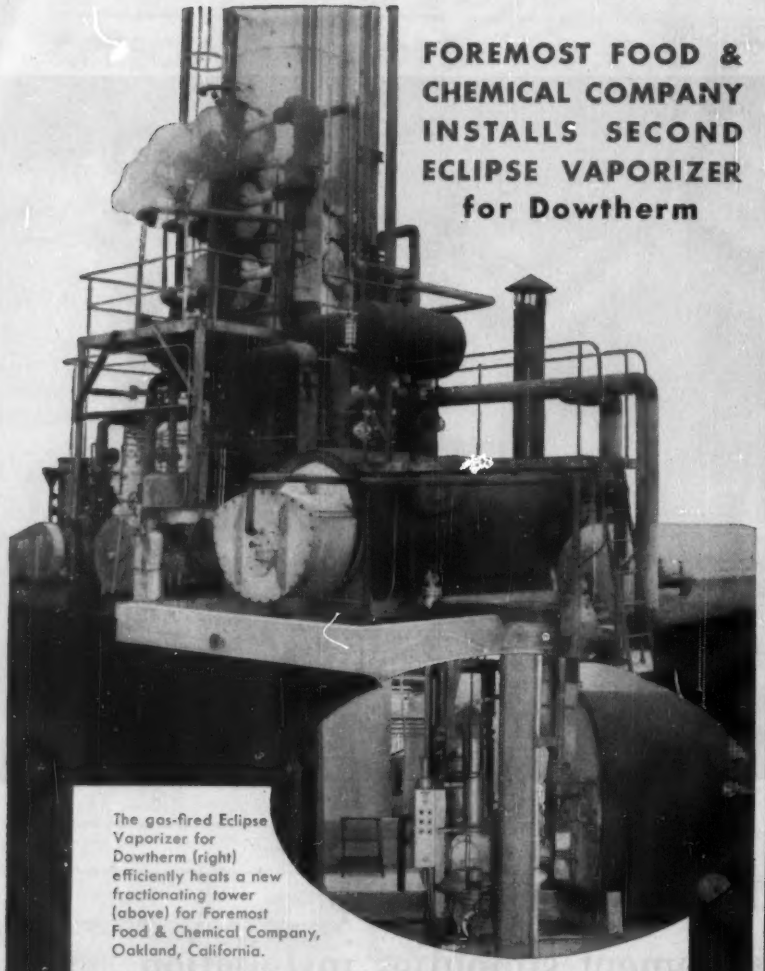

FOREMOST FOOD & CHEMICAL COMPANY INSTALLS SECOND ECLIPSE VAPORIZER for Dowtherm

The gas-fired Eclipse Vaporizer for Dowtherm (right) efficiently heats a new fractionating tower (above) for Foremost Food & Chemical Company, Oakland, California.

Fully satisfied with the high rate of heat transfer achieved with its first Eclipse 2,000,000-Btu. Vertical Vaporizer for Dowtherm, bought several years ago, this processor reports complete success with the new 3,000,000-Btu. Eclipse Horizontal Vaporizer recently installed. The fully automatic, continuously cycled Eclipse unit is a perfectly dependable heat source for a new fractional distillation process. It gives a very low temperature differential between heat transfer medium and product, requires minimum attention, and saves on fuel.

Exclusive design features—the large enclosed furnace of Eclipse Horizontal Vaporizers for Dowtherm permits high heat output without strain. Burning gases reverse direction in a rear chamber and return turbulently through completely immersed firetubes to the stack at front of unit. Turbulent flow, plus special design of firetubes, increases heat-transfer rate — minimizes flue loss. Low liquid level permits gravity return of condensate, eliminating need of pumps. Special design features substantially reduce maintenance costs. Ask your Eclipse representative about the many advantages.

ECLIPSE FUEL ENGINEERING CO.
1121 Buchanan Street, Rockford, Illinois
ECLIPSE FUEL ENGINEERING CO. OF CANADA, LTD.
20 Upjohn Road, Don Mills, Ontario

ASK FOR CURRENT CATALOG. High-temperature, low-pressure vapor and liquid phase process heating applications with Eclipse vaporizers and heaters for Dowtherm are described in Bulletin A-100. Write for your copy.

Export: Ad. Auriema, Inc., 85 Broad St., New York 4, N. Y.

Eclipse

STEAM-BOILER AND HIGH-TEMPERATURE HEAT-TRANSFER DIVISION

LITERATURE . . .

Centrifuges.....A four-page brochure of specifications on the De Laval line of centrifuges for the process industry is available on request. Send for your copy.
1 *De Laval Separator Company

Centrifuges, Hermetic.....with long-life seals at inlet & outlets maintain positive pressure throughout the centrifuging process. Details in booklete S. A969 & S. A983.
111 *The De Laval Separator Co.

Collector.....The new Therm-O-Flex collector features glass silicone treated filter tubes that handle gases as hot as 550 F. & has no moving parts. Literature.
62 *Western Precipitation Corp.

Cooling Towers.....Catalog No. CT-ID-0.050 contains general specifications on counterflow induced draft cooling towers. Features many illustrations.
234A Fluor Products Company

Crushers & Grinders.....Design provides easy access for cleanouts & returns complete sample. Bul. No. 067 gives full description of all laboratory machines.
R242 *Sturtevant Mill Co.

Dust Collectors.....from 500 cfm through 64,000 cfm for collecting such widely varied dusts as hemitite, copper & uranium ores, coal, quartz, etc. Bul. 231-11.
7 *Joy Manufacturing Co.

Dust Control.....Duclone collectors feature a steep cone which improves dust separation, a dust trap which assures efficient dust removal from the cone, etc. Bul. C-958.
209 *The Ducon Company, Inc.

Equipment, Ion Exchange.....for removal of mineral impurities from solvent solutions, chemical intermediates etc. General information in Bul. 200.
60 *Industrial Filter & Pump Mfg. Co.

Equipment, Plastic.....Process tanks & pilot plant equipment. Chemical storage & processing tanks & covers. Vents, Ducts, Hoods, Pipes and fittings.
13 *Carl N. Beetle Plastics Corp.

Filter Aids.....Celite, the diatomite filter aid with a wide range of grades. Its lower wet desity provides greater surface coverage per pound.
36-37 *Johns-Manville

Filter Leaves.....Bulletin No. 583 contains complete information on the many different properly designed filter leaves which can help you meet your needs best.
B240 *Multi-Metal Wire Cloth Co., Inc.

Filters.....Catalog, up-to-date fully illustrated reference manual of erection, operating, design & construction data & specifications is available.
229 *D. R. Sperry & Co.

Filters, Metal Edge.....The filter, constructed of monel, combines a porous metal facing on a frameless metal edge element. Two brochures outline all filters.
45 *Purolator Products, Inc.

Filter, Rotary.....24-page bulletin describes the designs of the five principal types of rotary drum filters and their component parts, accessories and auxiliaries.
234B Dorr-Oliver Inc.

* From advertisement, this issue

Materials of Construction

Acrylics
Alloy Steels
Aluminum
Asbestos
Beryllium
Carbon & Graphite
Carbon Steels
Cast High Alloys
Cellulosics
Clad, Bonded Steels
Copper
Epoxies
Fluorocarbons
Furanes
Fused Silica
Glass
Gold
Irons
Lead
Magnesium
Molybdenum
Nickel
Nylon
Phenolics
Platinum
Polyesters
Polyethers
Polyethylenes
Polystyrene
Polyurethanes
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MATERIALS. Circle code numbers for your copies of current literature.

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M-2	M-41	M-80	M-119	M-158	M-197	M-236	M-275	M-313
M-3	M-42	M-81	M-120	M-159	M-198	M-237	M-276	M-314
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M-5	M-44	M-83	M-122	M-161	M-200	M-239	M-278	M-316
M-6	M-45	M-84	M-123	M-162	M-201	M-240	M-279	M-317
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M-39	M-78	M-117	M-156	M-195	M-234	M-273		

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COMPANY:

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CITY, STATE:

(This Materials of Construction issue card expires Dec. 31, 1959.)

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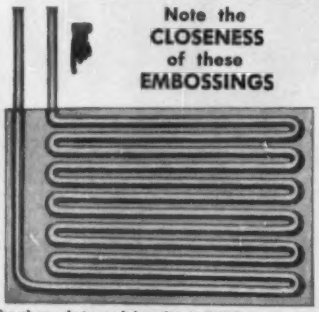

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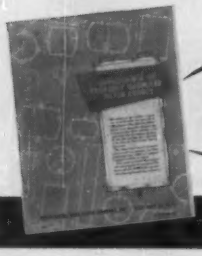

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240B Ducon Co., Inc.

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240C Cherry-Burrell Corp.

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31 *Traylor Engineering & Mfg. Co.

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Pneumatic Conveying Systems..... New 16 page illustrated bulletin points out how pneumatic conveying systems can reduce operating costs and improve plant efficiency.
240F Day Sales Co.

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240G National Conveyors Co.

Pneumatic Handling Systems..... Three basic pneumatic handling systems for safe, speedy and sanitary moving of dry, bulk materials are described in Bulletin ER-G-2.
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223 *Blaw-Knox Co.

Process Equipment.....Bulletin 968 is a buyer's guide to corrosion resistant process equipment. Bulletin 932 gives facts about Pfaudler Glasteel.
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75 *The Strong-Scott Mfg. Co.

Saw-Tooth Crusher.....SS-204 illustrates and describes a special heavy-duty saw-tooth crusher designed for reduction of warm plastic stock. Saws are 16 in. dia.
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Sea-Water Evaporators.....Ship and shore sea-water evaporators are described in illustrated 24-page booklet. Flow diagrams, size charts and engineering data.
241B Emhart Mfg. Co.

Scrubber.....Bulletin HP955-A diagrams and describes the Type A2 Hydro-Precipitator Scrubber, which traps noncondensable and dust-type materials below 5 mic.
241C Johnson-March Corp.

Separators, Centrifugal.....Continuous solid-bowl centrifugal installations cover everything from aluminum hydrate to zinc sulphide, from coal to cryolite, etc.
4 *Bird Machine Company

Splash Goggle.....Flyer reports on features of a new goggle for splash, spray and impact protection. Indirectly ventilated, comfortable, lightweight.
241D American Optical Co.

Steam Jets.....Bulletin M/5 describes corrosion resisting steam jets for heating, circulation, agitation and digestion. Construction diagrams. Send for your copy.
241E The Duriron Co., Inc.

Submerged Combustion.....Bulletin 115 covers a submerged combustion system for evaporation or concentration, liquid heating and melting operations.
241F Thermal Research

Thin-Film Processor.....A new high-vacuum processing unit, the Vacu-Film Processor extends thin-film processing to 0.5 micron range. Bulletin PE-117 describes.
241G Rodney Hunt Machine Co.

Vacuum Operations.....Advanced high-vacuum impregnating, drying, degassing and filming techniques are described in Bulletin I-2. Graphs and technical information.
241H NRC Equipment Corp.

Vibrating Screen Separators.....A new catalog describing three sizes of vibrating screen separators presents operating, application and specification data.
241I Southwestern Eng. Co.

Wine Clarifiers.....New bulletin covers three types of centrifuges used for wine clarification—the KG Standard, the Automatic Desludger and Hermetic Clarifier.
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For uniform strength in shipping containers, C. F. Downey Box Division keeps a watchful eye on the adhesives used. They formerly measured the water into the starch-base mix by filling a large, square tank up to a mark. It was tough to hit the mark on the nose every time. Too *much* water would make the adhesive too thin, and it was difficult to add starch to the finished cook. Too *little* water and the adhesive had to be dumped quickly before it clogged the tank and lines. It cost $100 every time an error wasted a batch.

Now an accurate Neptune meter does the measuring...with assured results and no losses or rejects. The meter pays for itself over and over again in starch savings alone.

Similar savings in time and ingredients can be made in *your* plant, by adding Neptune meters wherever liquids are batched, blended or transferred. Tell us what you want meters to do for you and we'll gladly tell you the best, most economical way. Write today for Bulletin 566 B

See Neptune data pages in Chemical Engineering Catalog.

METER-PRINTED TICKETS give dispute-free record of every batch . . . perfect for quality control, cost accounting, inventory. Other Neptune features: Auto-Stop quantity control; Auto-Switch electrical control for pumps; Stainless Steel construction.

NEPTUNE METER COMPANY
19 West 50th Street • New York 20, N.Y.

neptune

Branches in: ATLANTA • BOSTON • CHICAGO • DALLAS • DENVER • LOS ANGELES • LOUISVILLE • NO. KANSAS CITY, MO. • PHILADELPHIA • PORTLAND, ORE. • SAN FRANCISCO (Millbrae) • In Canada: TORONTO 14, ONT.

BISHOP PLATINUM SALTS AND SOLUTIONS

Continuously, since 1842 Bishop has been devoted to the manufacture of platinum and platinum group metal salts and solutions of the ultimate in quality. The Bishop background of skills, experience and steady development assures products of the finest quality obtainable . . . *from stock for immediate shipment.*

- Chloroplatinic Acid
- Platinum Oxide
- Palladium Chloride
- Rhodium Chloride
- Ruthenium Chloride
- Ammonium Chloroplatinate
- Potassium Chloroplatinate
- Sodium Chloroplatinate

. . . and 33 other platinum group metal chemicals.

Complete list of Bishop platinum and platinum group salts and solutions sent *promptly* on request.

OTHER BISHOP PRODUCTS:
Platinum Fabricated Products
Stainless Steel and Nickel Tubing

Chemical Division
J. BISHOP & CO.
PLATINUM WORKS
MALVERN, PA.

LITERATURE . . .

Pumps, Blowers, Compressors

Air-Conditioning System.....Kathabar systems maintain spaces at 80F & 55% RH, or lower, for processing, storage & testing. For use in various industries.
52 *Surface Combustion Corp.

Air Handling.....A 32-page booklet covers the treatment and distribution of air, and the products that the manufacturer has available to do the job.
242A Westinghouse Sturtevant

Air-Moving Equipment.....Handy reference guide for those interested in operation and installation of blowers, fans, exhausters and other similar equipment offered.
242B Wm. W. Meyer & Sons, Inc.

Air Jet Generator.....helps solve defoaming problems. Full information on this new economical approach to perfect defoaming contained in Bulletin RB-12.
219 *Gulton Industries, Inc.

Compressors.....Eight-page bulletin covers line of heavy-duty, low-pressure compressors having capacities from 756 to 7392 cfm. Run-down on parts and features.
242C Joy Mfg. Co.

Fans, Rubber-lined.....No possibility of separation, hardening or cracking. Whatever the type of severe service there is a fan to handle the job. Details in Bul. 2424-F.
40 *Buffalo Forge Co.

Pumps.....Bulletin 20 employs 19 tables to aid in the selection of power-driven pumps for a wide variety of applications. Line covers 10-1, 580 gpm. capacity.
242D Blackmer Pump Co.

Pumps.....Three shaft & rotating parts assemblies provide for 41 sizes of 2 popular pumps. Details on this interchangeability are contained in bulletins 721.6 & 722.6.
114 *Goulds Pumps, Inc.

Pumps.....Top ability to resist corrosion & top ability to move liquids economically & dependably are combined in these chemical pumps. Facts contained in Bul. B-1b.
42 *The LaBour Company, Inc.

Pumps.....to handle liquid oxygen & other liquefied gases, which can be liquified only at very low temperatures. Special features are outlined in Bul. 203-7.
212 *Lawrence Pumps Inc.

Pump, Canned.....A new equipment item, the Reversa-flo positive displacement canned motor and pump is claimed to eliminate all inherent problems of conventional units.
242-E Reversa-Flo

Pumps, Acid.....available with pumping parts of the machinable alloys as well as plastic to meet all requirements. Handles corrosive liquids. Information offered.
132 *A. R. Wilfley & Sons, Inc.

Pumps, Centrifugal.....Bulletin 721.6 describes manufacturer's line of single-stage, double-suction centrifugal pumps with horizontally split cases.
242F Goulds Pumps, Inc.

* From advertisement, this issue

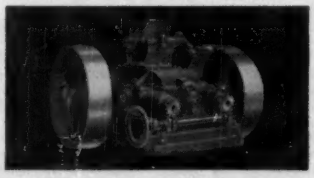
Take Guesswork Out of Lab Crushing & Grinding

Sturtevant Design Provides Easy Access for Cleanouts — Returns Complete Sample

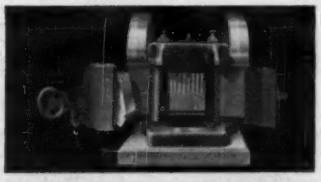
In seconds, because of "Open-Door" accessibility, all Sturtevant crushing or grinding parts are exposed for thorough cleanouts. 100% sample return is easy to secure.

Sturtevant laboratory machines are ruggedly constructed — design, based on production models, gives top lab or pilot performance.

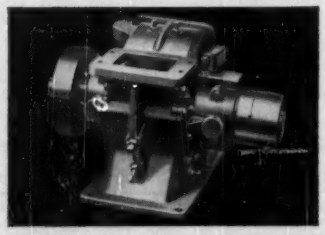
Send for Bulletin No.067, which gives full description of all Sturtevant laboratory machines.



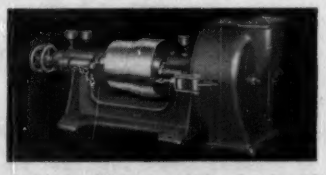
Lab Crushing Rolls: Special lab design. Two models: 8 x 5 in. and 12 x 12 in. rolls. Capacities to 10 tph. Both models adjust down to 20 mesh. Tires of high carbon forgings. Automatic feeder, adjustable controls.



Lab Jaw Crusher: Crushes hardest rocks at ½ to ⅛ in. settings. Roll jaw action — no clogging. Feed opening 2 x 6 in. Capacity to 1900 lbs. per hr. at ½ in. setting. Instant adjustment. Manganese jaws, reversible shield.



Lab Swing-Sledge Mill: 5 x 6 in. opening takes soft, medium, tough or fibrous feed. Capacity to 1 tph. Fines regulate from 1 in. to 20 mesh. Choice of gratings, hammers (or knives).



Sample Grinder: Disc type grinders for dry, friable soft or medium materials. Three sizes — 6 in., 10 in., and 14 in. take feed as coarse as ¼ in. Produces 100 mesh fines at capacities to 200 lbs. per hr. on largest model. Regulate 10 to 100 mesh. In-operation adjustment.

STURTEVANT
MILL COMPANY
100 Clayton St., Boston 22, Mass.

Pumps, Feeder.....Literature describes line of positive displacement variable-volume chemical feeder pumps. Only part contacting chemical replaced in 3 min.
243A Limpert Laboratory Inc.

Pumps, Horizontal Triplex.....are available in capacities from 50 to 6500 GPH...pressures from 500 to 12000 PSI...horsepower to 150. Details in Bul. P-55.
118 *Manton Gaulin Mfg. Co.

Pumps, Reciprocating.....Simplex and duplex pumps for proportioning and power service, with capacities to 675 gph., pressures to 4575 psig., described in Bul. 758.
243B Jaeco Pump Co.

Pumps, Vacuum.....Microvac pumps are compact-require little height or floor area. Models with up to 500 c.f.m. displacement. Complete literature offered.
201 *J. J. Stokes Corp.

Pumps, Vertical Turbine.....Bulletin No. 100 gives details on the design & engineering on water wells, water treatment and vertical turbine pumps.
50 *Layne & Bowler, Inc.

Services, Processes, Misc.

Analytical Balances.....32 p. "Balance Bulletin" illustrates and thoroughly describes a complete line of balances, weights and accessories. Send for your copy.
243C Harshaw Scientific

Atom Models.....6 p. brochure describes a line of atom models. Illustrations show how they are assembled and disassembled. Ask for bulletin 10a58.
243D Arthur S. LaPine & Co.

Boiler Cleaning.....Bulletin describes a new technique for hydroxy apatite boiler scale removal which reduces downtime as much as 30 hr. for high make-up boiler cleaning.
243E Dow Chemical Co.

Computation Centers.....Booklet describes analog computing equipment installed at company's computation centers in Princeton, N. J., Los Angeles, Calif., Brussels, Belgium.
243F Electronic Assoc., Inc.

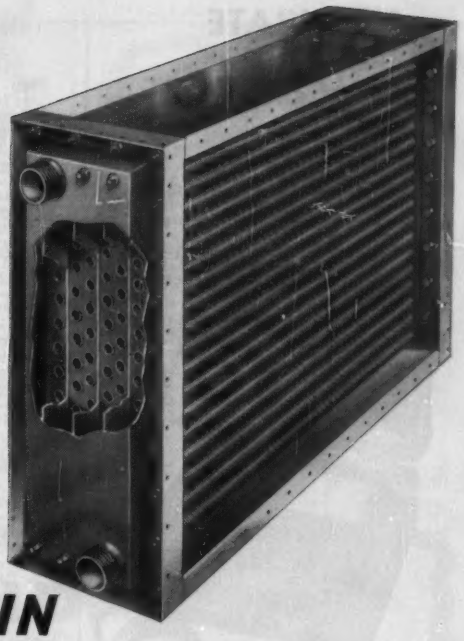
Construction Service.....Full details of complete engineering and construction services for the chemical industry are available on request. Send for your copy.
102 *J. F. Pritchard & Co.

Dust Control Equipment.....Bulletin 82 assists engineers concerned with industrial dust control problems of all kinds. Also includes selection and pricing information.
243G The Flexaust Co.

Engineering Service.....A 6-page folder describes firm's services: equipment and building design, preparation of drawings, supervision of construction.
243H Burns and Roe, Inc.

Fire Extinguisher.....Dry chemical extinguisher is now available. The powder is nontoxic, will not freeze, corrode or conduct electricity.
29-30j *U. S. Industrial Chemicals Co.

* From advertisement, this issue



AEROFIN

TYPE R Removable-Header WATER COILS

- Complete Drainability
- Easily Cleaned
- High Heat Transfer

Completely drainable and easily cleaned, Aerofin Type "R" coils are specially designed for installations where frequent mechanical cleaning of the inside of the tubes is required.

The use of 5/8" O.D. tubes permits the coil to drain completely through the water and drain connections and, in installations where sediment is a problem, the coil can be pitched in either direction. The simple removal of a single gasketed plate at each end of the coil exposes every tube, and makes thorough cleaning possible from either end.

The finned tubes are staggered in the direction of air flow, resulting in maximum heat transfer. Casings are standardized for easy installation.

Write for Bulletin No. R-50

AEROFIN CORPORATION

101 Greenway Ave., Syracuse 3, N.Y.

Aerofin is sold only by manufacturers of fan system apparatus. List on request.

ACCURATE TEMPERATURE READINGS

- Hot Water Systems
- Floors, Walls, Ceilings
- Refrigerated Coils
- Insulation
- All Other Low Temps.

You can accurately read any low surface temperature with the Alnor Type 2300 Surface Pyrometer—in 3 to 5 seconds.

Take this rugged, portable instrument to any job in the field and see how performance to laboratory standards can save invaluable time in balancing out a system...save the money lost on call-backs. Large 6" mirrored scale is direct reading, no conversion ...no errors in readings...1° per division. Precision jeweled movement is protected against abuses of portable service by sturdy walnut case. Comes complete with matched thermocouple and lead ready to use on your next trip out. Send for Bulletin 4257 and get the complete story on the full line of Alnor Pyrometers. Just tear out this ad and mail on your letterhead to: Illinois Testing Laboratories, Inc., Room 559, 420 N. LaSalle St., Chicago 10, Ill.

Alnor

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

LITERATURE . . .

Fire Extinguishers.....Complete information available on the new 200-lb. pressurized unit and the new 20-lb dry chemical portable unit. Send for your copy.
210 *Walter Kidde & Co., Inc.

Fume Hoods.....Catalog DH? features 26 illustrated pages on Slimline & conventional chemical fume hoods. Contains complete specifications. Laboratory accessories included.
244A Duralab Equipment Corp.

Glassware, Laboratory.....88 p. Catalog 89A58 list 377 glass items, including everything from adapters to stopcocks. Includes illustrations, prices.
244B Fischer & Porter Co.

Jet Cleaners.....Bulletin covers line of modern cleaning equipment for process equipment, walls, floors, and tanks or tank cars. Drawings and specifications.
244C Sellers Injector Corp.

Materials, Corrosion-proof.....Bulletin CC-3 gives complete information on corrosion-proof cements, & tank linings. Also details on rigid plastic structures.
L220 *Atlas Mineral Products Co.

Nuclear Reactor.....experiments are described in new book now being sold. Volume outlines problems of design, construction, operation of reactors, etc.
29-30h *U. S. Industrial Chemicals Co.

Nuclear Safety Equipment.....New items cataloged in Bulletin N-35 include shielded storage containers, lead shields, bricking, timers, warning tape and signs, etc.
244D Nucleonic Corp.

Oil-Field Water Service.....A complete oil-field water consulting service is described in a new bulletin. Service assures maximum oil removal.
244E Bradford Laboratories

Refinery Construction.....Bulletin presents a picture of the various factors involved in the design and construction of a refinery. Shows typical completed projects.
244F Southwestern Engr. Co.

Structures Design, engineering, fabrication & erection of steel plate structures. Bulletins on: Special Plate Structures & Field Services are available.
26-27a *Chicago Bridge & Iron Co.

Syringe, Polyethylene.....for applying adhesives, potting compounds, etc. It is disposable. Said to deliver exact quantities of fluid without flooding, starving or dripping.
29-30n *U. S. Industrial Chemicals Co.

Tank Cleaning Unit.....Model 531 automatically sprays hot cleaning solution under pressure. Nozzles rotate vertically & horizontally. Rinses after cleaning. Details.
206 *Oakite Products, Inc.

Waste Treatment.....Data Sheet D58-1 describes continuous cyanide and chrome wastes treatment systems. Contains flow diagrams, ratioing techniques.
244G Milton Roy Co.

Wood Products.....First issue of the **NWPP News Bulletin** (National Wood Promotion Program) is now available. Bulletin will hereafter be published on a monthly basis.
244H National Lumber Mfg. Assoc.

* From advertisement, this issue

PROFESSIONAL SERVICES

E. J. CORELL
ENGINEER
Chlorine—Soda Ash—Perchlorethylene
Pigments and Related Products
Design—Reports—Operation
412 Rose Blvd. Akron, Ohio
Tels: Akron, O. TE 64271

MERRILL W. MacAFEE
Consulting Engineer
Chemical-Metallurgical-Mining
LUdlow 3-1778 FRontier 5-6145
7668 Santa Fe Ave. Huntington Park, Calif.

The C. W. NOFSINGER COMPANY
"In Engineering It's the PEOPLE that Count"
Engineers and Contractors for the Petroleum and Chemical Industries
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KNOWLES ASSOCIATES
Chemical—Metallurgical—Mechanical Engineers
Consultation—Design
Complete Plants—Equipment
Heavy Chemical—Ore Dressing
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Bowling Green 9-3456

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Consultants • Engineers • Constructors
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Offices Throughout the World

FOSTER D. SNELL, INC.
Chemical & Engineering Consultants
Research, Process Development, Pilot Plant Studies. Plant Design, Location Studies Construction Supervision. Start-Up & Operation. Equipment Design. Packaging & Materials Handling Studies. Cost Analyses. Trouble Shooting.
29 W. 15th St. WA 4-8800 New York 11, N. Y.

When you need a SPECIALIST in a hurry . . .

Chemical Engineering's Professional Service Section offers the quickest, most direct method of contracting consultants who may be available NOW.

EMPLOYMENT OPPORTUNITIES

▶ **Displayed Rates**—$46 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Subject to the usual agency commission.

▶ **Undisplayed Rates**—$2.10 per line, 3 lines minimum. To figure advance payment count 5 average words as a line; box number count as 1 line. 10% discount if full payment is made in advance for 4 consecutive insertions. Not subject to agency commission.

CHEMICAL ENGINEER

P. H. D.

5 Years Minimum
Research Experience in
Petroleum, Natural Gas or Petrochemical
Age to 45
Excellent Opportunity
in our
New Research and Development Department
LOCATED IN EL PASO, TEXAS

Apply in Writing
Enclosing Detailed Experience Resume to
Employment Supervisor

EL PASO NATURAL GAS COMPANY
P. O. Box 1492 El Paso, Texas

PLASTIC PIPE SALES MANAGER

Amply financed South Atlantic manufacturer, just building PVC extruded pipe plant, seeks Ch. E. Graduate, under 40, to develop sales and sales promotion. Must have substantial background in plastics, know jobbing channels, and have proven record in sales management. Replies should include full detail of education, work record, earnings, availability and recent picture.

Wally E. George, Management Consultant
425 Cherry, S.E., Grand Rapids 2, Mich.

ADDRESS BOX NO. REPLIES TO: Box No. Classified Adv. Div. of this publication. Send to office nearest you.
NEW YORK 36: P. O. BOX 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

POSITION VACANT

Process Engineer. Chemical Engineers with experience in Petroleum Refining sought by "America's Fastest Growing Oil Company." Send complete resume, including salary requirements, to Employee Relations Department, P. O. Box 2039, Tulsa, Oklahoma. All replies confidential.

SELLING OPPORTUNITIES OFFERED

Manufacturer of Heat Exchangers and Pressure Vessels, located in New Jersey, wants sales representatives in various parts of country. Representatives should have contacts in oil refineries, power plants, chemical plants or marine. RW-8806, Chemical Engineering.

Manufacturers' representative desired for a complete line of solid adsorbent instrument air dryers and compressed gas dehydrators in all territories east of the Mississippi River. Representatives should be selling instrumentation and equipment to oil refineries, chemical plants, and power plants. Gas Drying Inc., Box 56, Summit, N. J.

(Continued on the following page)

CLASSIFIED . . .

EQUIPMENT SEARCHLIGHT

CE's Searchlight spots the big bargains in used, resale and rented equipment. Check this issue's listings—most complete in the field—for items you need now.

▶ **Coverage** — National. Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

▶ **Rates**—$21.75 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Ads acceptable only in display style.

▶ **Closing date** — January 12th issue closes December 19th. Send all new ads to Chemical Engineering, Classified Adv. Division, P. O. Box 12, New York 36, N. Y.

LIQUIDATION

DONORA ZINC WORKS **DONORA, PA.**

1—Traylor 10' x 120' Rotary Kiln, ¾" shell.
2—Ruggles Cole 90" x 55' Class A14 Rotary Dryers, 7/16" shell.
2—Herreshoff 20' dia., 16 hearth, Furnaces.
1—Buflovak 550 sq. ft. Monel Single Effect Evaporator.
2—Swenson 6'6" dia. x 5' deep, steel, jacketed Vacuum Pans.
1—Blaw-Knox 1400 gal. steel, jacketed, agitated Vacuum Kettle.
1—10,000 gal. Horizontal Steel Pressure Tank, 200# pressure.
10—Lead lined, agitated Tanks, 1000 to 6500 gallons.
Troughing Belt Conveyors; Bucket Elevators; Bins, 50 to 500 tons; Ball Mills; Jaw Crushers; Roll Crushers; Air Compressors.

SEND FOR CIRCULAR **REPRESENTATIVE ON PREMISES**
FOR PROMPT ACTION CALL DONORA, PA. **Tel. FRONTIER 9-9789**

STOCK ITEMS

1—4000 gal. 347 S.S. jacketed Reactor, 150# internal.
1—Blaw-Knox 500 gal. 304 clad, jacketed, agitated Reactor.
2—Pfaudler 1500 gal. glass lined, jacketed, agitated Reactors, 90# jacket.
1—750 gal. nickel clad Mixing Tank, 125# internal, with nickel coils.
4—Buflovak 750 gal. steel, jacketed, double motion paddle, agitated kettles.
2—Patterson 1000 gal., steel, jacketed, agitated Reactors, 20 HP.
1—Vulcan Briquetting Press, 30" dia. x 12½" face, 304 S.S. rolls, 50 HP.
1—3500 gal., 304 S.S. jacketed, agitated Tank, 9' x 7'.
1—Haveg 4000 gal. closed Storage Tank.
1—5000 gal. 304 S.S. Horizontal Tank, 6'6" x 20'. Unused.
5—Stainless Heat Exchangers, 1220, 1080, 786, 500, 370 sq. ft.
2—Sharples C20 & C27 Super-D-Hydrator, 316 S.S., vapor tight XP Timers.
2—Sharples PN14 & PY14 Super-D-Canters, 316 S.S.
1—Sharples H2 Nozzlejector, 15 HP, 304 S.S.
4—Bird 18" x 28", 24" x 38", 316 S.S. continuous Centrifuges.
3—American 42" x 120" Double Drum Dryers, 10 HP motors.
1—Buflovak 48' x 40" nickel, single drum Flaker.
1—Bird 40" suspended Centrifugal; 347 S.S. imperforate basket, 1800 RPM.
2—Buflovak 250 & 20 sq. ft., 304 S.S. forced circulation Evaporators.
2—Sparkler 33-S-28 Pressure Filters, 150 sq. ft., 304 S.S.
1—Niagara 36 H-110 horizontal 304 S.S. Filter, 110 sq. ft.
1—Baker Perkins #16 TRM, 150 gal., jacketed sigma blades, Vacuum Mixer.
1—Baker Perkins #15 VUMM, 100 gal. jacketed Mixer, 100 HP motor.
3—Stokes R, single punch Tablet Machines, Unused.
1—Dowtherm 360,000 BTU Vaporizer.

PARTIAL LIST OF VALUES **SEND FOR NEWS FLASH**

BRILL EQUIPMENT COMPANY
2401 THIRD AVE., NEW YORK 51, N. Y.
Tel. CYpress 2-5703 · Cable: Bristen, N. Y.
TEXAS OFFICE—4101 San Jacinto St., Houston 4, Texas—Tel. Jackson 6-1351

FIRST Class Equipment
FROM YOUR FIRST SOURCE

RUBBER and PLASTIC UNITS

* Battery of NEW UNUSED 14" x 30" Two Roll F-B. Mills with UNI-Drives
* Line of F-B. Mills 42" and 60" Rolls
* Stewart Bolling 2 Roll Mill 8"x16"
* Multi Platen Hydr. Presses 24" x 56" with (2) 10" Rams; 3000 PSI
* Erie Jacketed Extruder 6" x 66"
* Battery of Horizontal Sheeters Hydraulic 26" wide Knife
* Swego Cutter 63" wide with 10 HP
* Ball & Jewell Rotary Cutter 10 HP
* 425 Ton Horizontal Hydraulic Sheeting Extruder complete . . .

MILLS AND GRINDERS

Raymond 5 Roll Hi Side Mill with Whizzer and accessories
Mikro Pulverizers; all sizes from Bantam to No. 4
Mikro Atomizers; Stainless Lined; Models No. 5 and 5
International Porcelain Ind. Pebbles Mills 8'x8'; 50 HP
Abbe and Patterson Pebble Mills from 36"x42" to 6'x8'
Abbe Silex Lined Ball Mills: 5'x14' and 5'x16'
Patterson JACKETED Ball Mills: 54"x42"; good for Vacuum
1000 Gal. Jacketed Buhrstone Lined Pebble Mill; 6'x6'; 25 HP
Simpson Intensive Mix-Mullers 24", 30" and 72" Dia. Pans

CENTRIFUGALS

A. T. & M. 25" Stainless Suspended Type Centrifugal
A. T. & M. Rubber Cov. 30" Susp. Centrifugal; AnnDisch.
Tolhurst 36" S/S Suspended; with Plow and Bottom Dump
A. T. & M. 60" S/S Suspended center slung; Vapor tight
Sharples S/S Super-D-Canter; 10 HP
Sharples H2 Nozziejector; 1000 GPH
Sharples C20 Super-D-Hydrator in 316 Stainless; 20 HP
Bird Solid Bowl Continuous Centrifuge 32"x36"; 316 S/S

FILTERS

Dorrco Rot. Vacuum Filter; 6'x3' with nickel contacts
Feine S/S Rot. Vacuum Filter 8'x8' with accessories
Oliver Pre-Coat Rubber Lined Filter 8'x8'; 200 sq. ft. area

DRYERS AND KILNS

Proctor & Schwartz Apron Dryer 90" wide; 60' long complete
Rotary Kilns complete with accessories: 11'x155'; 8'x125'
Hersey Rotary Gas Fired Dryer 5'x26' Counter Current complete
S/S Lined Rotary Dryer 50"x20' with Burner, Combustion Chamber, etc.
Stokes Rot. Jkt'd. Dryer 18"x8'
Bagley & Sewell Double Drum Dryer 28"x60" complete
Buflovak Dbl. Drum Dryer 40"x120" with accessories
Struthers Well Stainless Drum

REACTORS—EVAPORATORS

New S/S 125 Gal. Reactor; 30"x30" Jacketed; Agitated; motorized
Pfaudler Glass Lined Jacketed Reactor; 36"x36" agitated
Pfaudler Glass Lined Reactors 500 gal., 1,000 gal. and others
Blaw Knox Stainless Reactor 7'6"x7'x6"; Jacketed, Agitated
1500 Gal. Steel Jacketed and Agitated Heavy Duty Reactor
A. O. Smith Stainless Lined 11,000 Gal. Pressure Tanks
Rotating Jacketed Aluminum Vacuum Fermentor; 3'x3'
Mojonnier S/S Vac. Pans 3'x10' and 6'x12'
Harris Stainless Vacuum Pan 6' Dia. wth coils complete
Zaremba Dbl. Effect INCONEL Evaporator 430 sq. ft. surface
Swenson Quadruple Effect Long Tube Evaporator; film type
Sargent & Wilbur Ammonia Disassociator; 10,000 cu. ft. per H
Swenson Lead Evaporators with Everdur Tubes; 300 sq. ft.

SEND for NEW ISSUE of "FIRST FACTS"

FIRST MACHINERY CORP.
209-289 TENTH ST.
BROOKLYN 15, N. Y.
STerling 8-4672

BUY ON TERMS!

SPECIALS FROM OUR STOCK OF OVER 10,000

Centrifuge, A T & M 42" S.S. susp. perf. basket, 25 HP motor

Rotary Kiln, 8' x 100', ¾" riveted construction, mtr & drive

Filter, Niagara horizontal Model 36 H190, 21 stainless leaves

Ribbon Blenders, Day D-10, 30" x 33" x 78", center discharge, motor

Mixer, Readco dbl arm sigma blade jcktd Vac, 125# pressure

Mixers, Horizontal Paddle type, 180 & 360 cu ft capacity (4)

For any item you need, wire or phone collect GA 1-1380

MACHINERY AND EQUIPMENT COMPANY
123 Townsend St. · San Francisco 7, California

CRUSHERS—Jaw, 9 x 16 Climax—24 x 12 Farrel—15 x 40 Goodroads 36 x 10 Farrel —28 x 36 Traylor

CRUSHERS—Roll, 16 x 10 Sturtevant—18 x 24 Steele—24 x 16 Allis Chalmers—30 x 16 Chambers—Single 24 x 24 Link Belt 30 x 30 Jeffrey

MILLS—Hammer, 25 HP Williams AKB—30 HP Mikro 3 W—50, 100, 125 HP Jeffrey—350 HP Penna. SXT 13—450 HP Penna. SXT 14

SCREENS, 12" x 6" Ajax (s/s)—3 x 5, 3 x 10, 4 x 10 Tyler Hummer—40 x 84 Roball —40 x 120 Rotex—42" x 10" Cedar Rapids

MILLS—Hardinge Conical, 3' x 8", 4½' x 16", 5' x 36", 6' x 36" Air Swept—7' x 22", 8' x 36", 8' x 48", 10' x 48" all with motors

BAG PACKER, St. Regis 100LS (unused)—105FV, 100SL 2 spout for 25/50/100# valve type bags

MILLS—Pebble, Lab. 1 & 4 Jar—30 x 24, 30 x 42, 36 x 48, 5' x 4', 6' x 5' Porc. Lined —6 x 8 Buhrstone

YOUR BEST REBUILT MACHINERY SOURCE

LAWLER COMPANY
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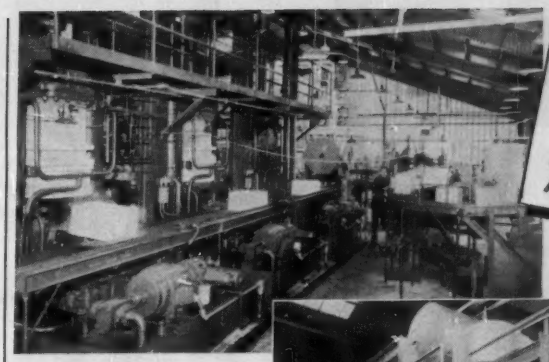
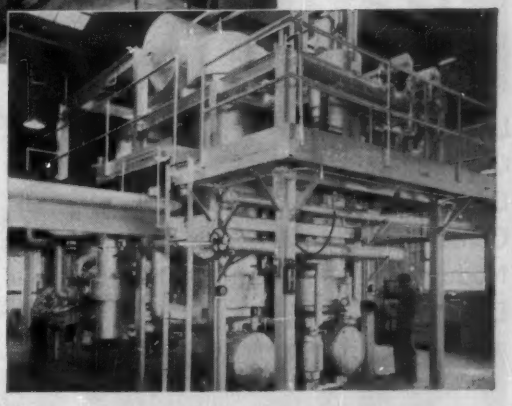


Each of the Cardox Corporation's three presses forms 240-lb. cakes of dry ice in 5½ minutes.



At Cardox Corporation's modern Memphis, Tennessee plant, Vilter vertical condensers change carbon dioxide gas into liquid. Vilter supplied a total of 18 custom designed vessels of which several are shown here.

Vilter Report Card

Grade	
A	Sturdy Construction
A	Reliable Performance
A	Low Maintenance
A	Efficient Design

100 tons of CO_2 produced per day using 18 Vilter pressure vessels

Using a new low pressure process, the Cardox Corporation's Memphis Plant turns out 100 tons of CO_2 per day. Plant operation is almost entirely automatic.

A large percentage of the major processing equipment is devoted to efficient heat transfer. Among these are eighteen custom-made heat exchangers and condensers manufactured by Vilter. Typical units include: Shell and Tube type ammonia-cooled condensers, Shell and Tube type water-cooled vapor cooler (all aluminum construction), liquid receivers, aftercoolers, condensers, oil separator, flash intercoolers, and ammonia surge drum among others. The largest Vilter unit supplied provides a heat dissipation capacity of 2,242,000 BTU per hour.

Vilter has successfully resolved many problems of cooling under both low and intense pressures; and has designed and produced hundreds of heat exchangers, pressure vessels, and high pressure synthesis condensers to exacting specifications for many types of chemical and petroleum applications. Vilter heat exchangers are efficient, reliable, and thoroughly inspected and tested prior to shipment.

Consult with Vilter about your heat exchanger needs.

Write for these helpful bulletins to The Vilter Manufacturing Company, Dept. K-808, 2217 S. First Street, Milwaukee 7, Wisconsin

Bulletin 817 Vilter VMC Ammonia Compressor

Bulletin 707 Vilter Condensers Brine Coolers Heat Exchangers

Bulletin 427 Vilter Industrial Heat Exchangers

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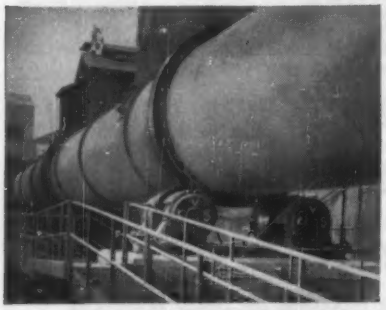

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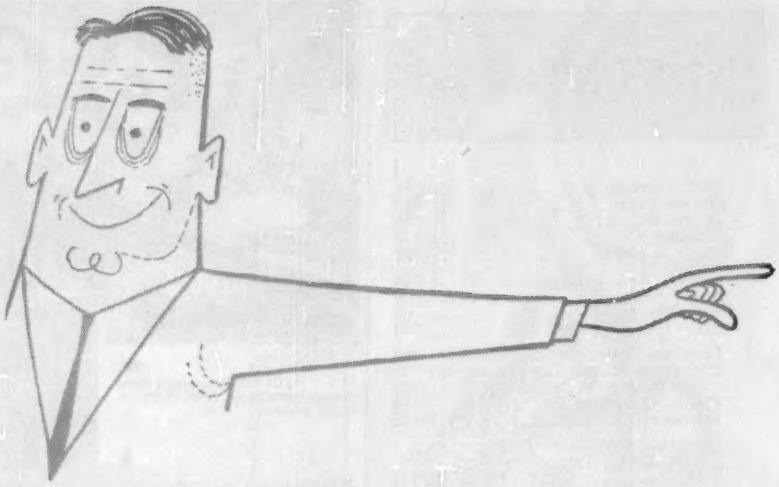

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BRIDGEPORT HEAT EXCHANGER AND CONDENSER TUBES FOR THE CHEMICAL AND PROCESSING INDUSTRIES

ALLOY	ADVANTAGES	NOMINAL COMPOSITION (%) COPPER	ZINC	ALUMINUM	NICKEL	TIN	ARSENIC	PHOSPHORUS	IRON	MANGANESE	SPECIFICATIONS ASME	ASTM	FEDERAL OR MILITARY
ARSENICAL ADMIRALTY 30	Good general resistance. Best for chem. & refinery services	71.0	27.92	....	....	1.05	0.03	....	....	....	SB111-54	B111-54	Federal WWT 756C (Navy)
ARSENICAL ALUMINUM BRASS 54	Excellent impingement resistance to aerated sea water	77.0	20.87	2.1	....	....	0.03	....	....	....	SB111-54	B111-54	MIL-T-10992A (Army & Navy)
DURONZE IV (ARSENICAL ALUMINUM BRONZE 53)	Top service in high velocity, clean or polluted sea or fresh water	94.25	....	5.5	....	....	0.25	....	....	....	SB111-54	B111-54	
70-30 CUPRO NICKEL 520	Superior for high velocity sea water and high operating temperatures	67.75	....	....	31.0	....	....	....	0.5	0.75	SB111-54	B111-54	MIL-T-15005B (Army & Navy)
80-20 CUPRO NICKEL 520	For similar but less severe service than 70-30, particularly brackish water	78.85	....	....	20.0	....	....	....	0.4	0.75	SB111-54	B111-54	
90-10 CUPRO NICKEL 3511	Iron content improves corrosion resistance	89.15	....	....	10.0	....	....	....	0.85	....	SB111-54	B111-54	MIL-T-15005B
ARSENICAL MUNTZ 142	Recommended for oil refinery installation as a solution to sulphur corrosion	62.0	37.9	....	....	....	0.1	....	....	....	SB111-54	B111-54	
RED BRASS 85	Gives excellent service under many specific conditions in oil refineries	85.0	15.0	....	....	....	....	....	....	....	SB111-54	B111-54	
DEOXIDIZED COPPER 105, 110	Long proved service for sugar refineries refrigeration applications, etc.	99.9+ Min.	....	....	....	....	....	0.02	....	....	SB111-54	B111-54	
ARSENICAL COPPER 108	Slight arsenic addition increases corrosion resistance	99.4+ Min.	....	....	....	....	0.3	0.02	....	....	SB111-54	B111-54	

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- Muntz Metal
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- Yellow Brass (70-30)
- Naval Brass
- 2% Silicone Bronze 609
- 3% Silicone Bronze 632
- Aluminum
- Monel
- Nickel
- Steel (low carbon)
- Stainless Steel
- Alloy Steels
- Tin

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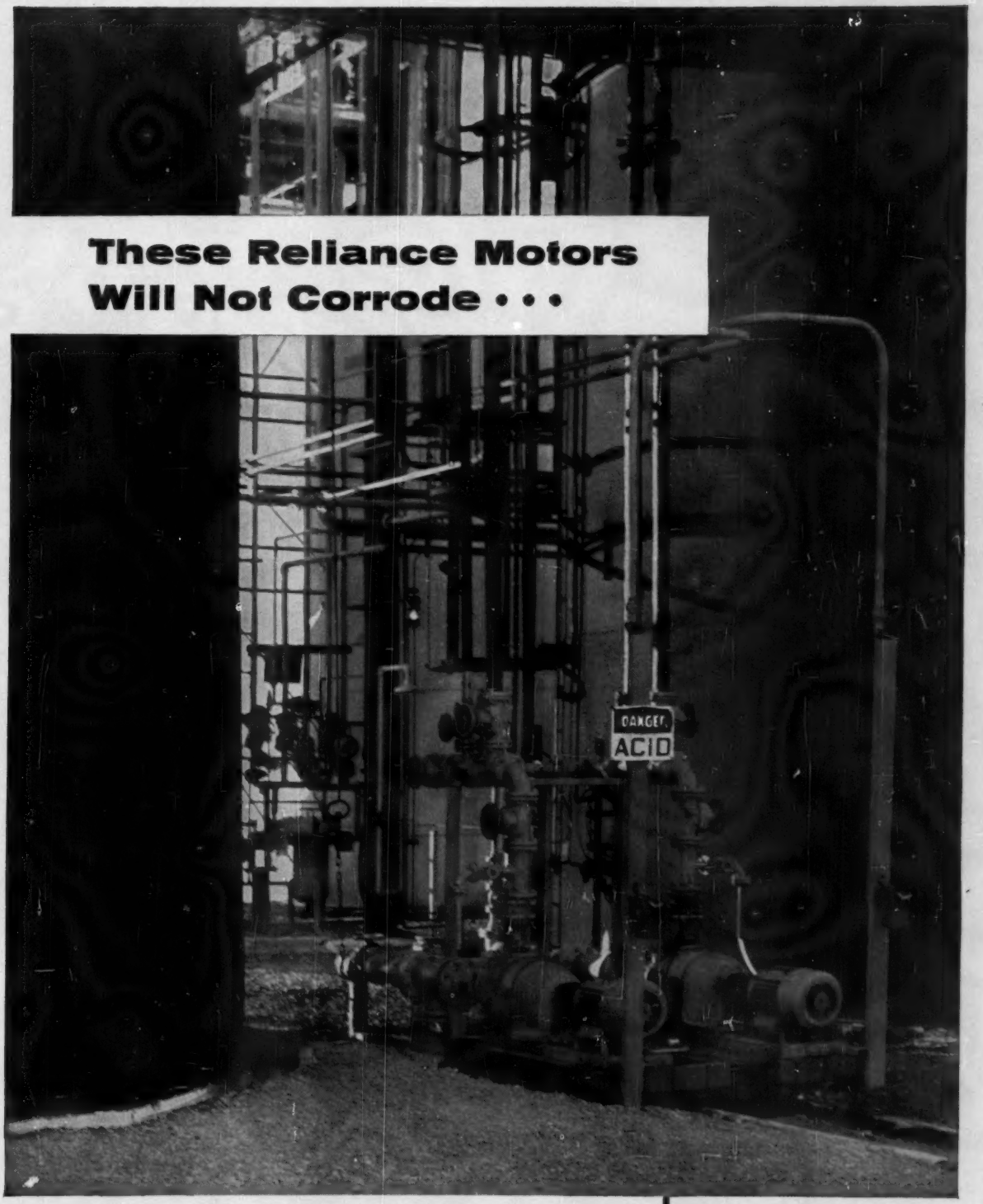
Warehouse stocks are strategically located from coast to coast for immediate delivery.



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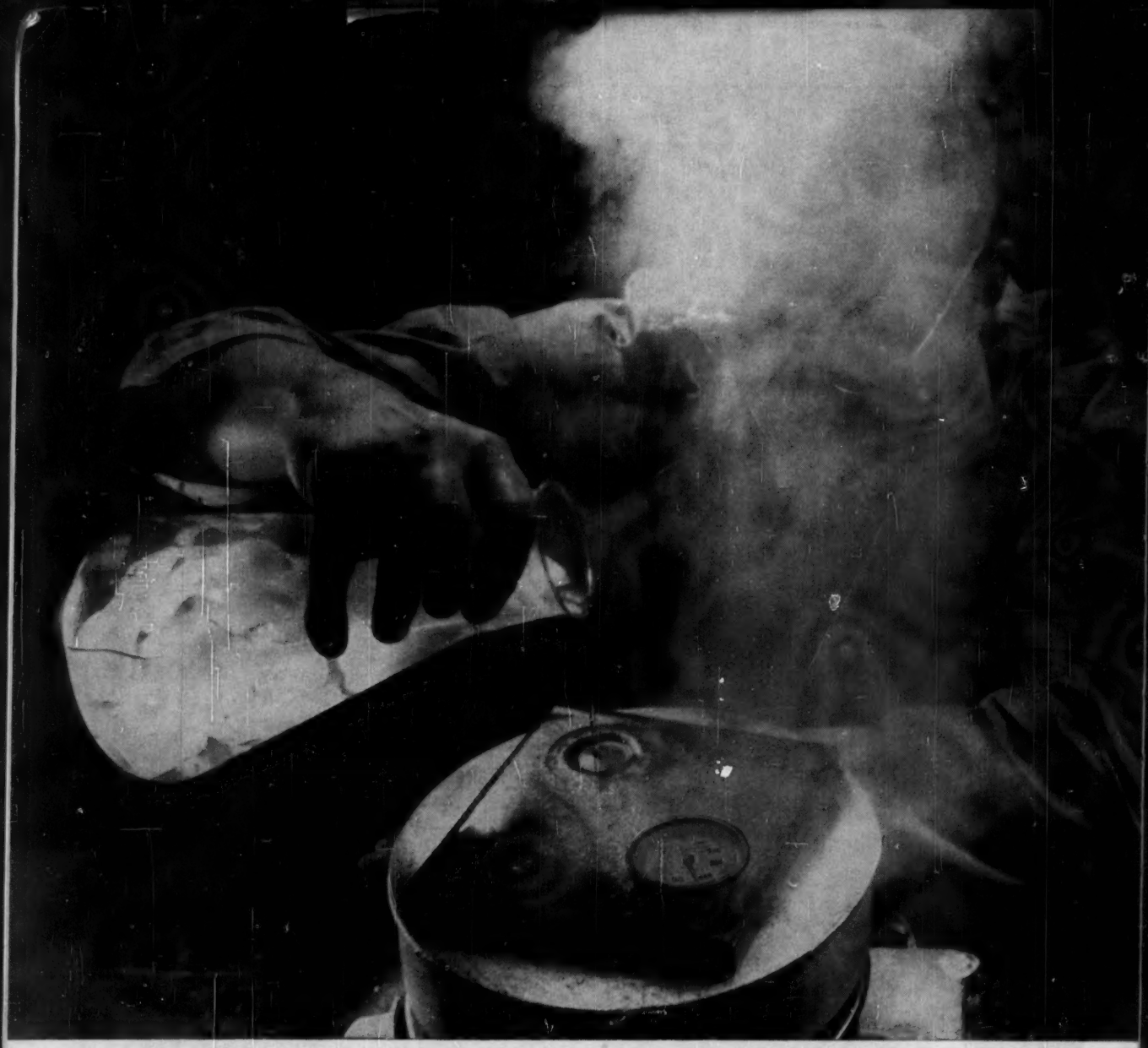

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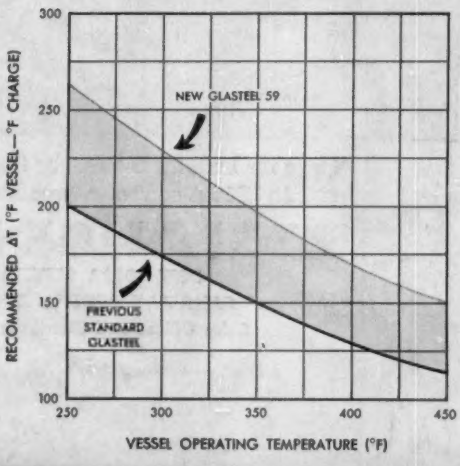

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